UDK 5 ISSN 1408-533X

ANNALES

Anali za istrske in mediteranske študije
Annali di Studi istriani e mediterranei
Annals for Istrian and Mediterranean Studies

series historia naturalis, 18, 2008, 1

KOPER 2008

ANNALES · Ser. hist. nat. · 18 · 2008 · 1

Anali za istrske in mediteranske študije - Annali di Studi istriani e mediterranei - Annals for Istrian and Mediterranean Studies

ISSN 1408-533X UDK 5 Letnik 18, leto 2008, številka 1

Prelom/*Composizione/Typesetting:* Franc Čuden - Medit d.o.o.

Tisk/*Stampa/Print:* Grafis trade d.o.o.

Izdajatelja/*Editori/Published by:* Univerza na Primorskem, Znanstveno-raziskovalno središče Koper / *Università del Litorale, Centro di ricerche scientifiche di Capodistria / University of Primorska, Science and Research Centre of Koper©*, Zgodovinsko društvo za južno Primorsko / *Società storica del Litorale©*

Za izdajatelja/*Per gli Editori/ Publishers represented by:* dr. Darko Darovec, Salvator Žitko

Sedež uredništva/ *Sede della redazione/ Address of Editorial Board:* Univerza na Primorskem, Znanstveno-raziskovalno središče Koper, SI-6000 Koper/*Capodistria*, Garibaldijeva/*Via Garibaldi* 1, p.p. /P.O.Box 612, tel.: ++386 5 66 37 700, fax 66 37 710; ***e-mail:*** annales@zrs.upr.si, ***internet:*** http://www.zrs.upr.si/

Redakcija te številke je bila zaključena 30. 6. 2008

Sofinancirajo/*Supporto finanziario/ Financially supported by:* Javna agencija za raziskovalno dejavnost Republike Slovenije, Ministrstvo za kulturo Republike Slovenije, Ministrstvo za šolstvo in šport Republike Slovenije, Mestna občina Koper, Občina Izola, Občina Piran, Banka Koper

Annales - *series historia naturalis* izhaja dvakrat letno.
Annales - *series historia et sociologia* izhaja dvakrat letno.

Letna naročnina za obe seriji je 29,21 EUR, maloprodajna cena tega zvezka je 10,43 EUR.

Naklada/*Tiratura/Circulation:* 700 izvodov/*copie/copies*

Revija Annales series historia naturalis je vključena v naslednje podatkovne baze: BIOSIS-Zoological Record (UK); Aquatic Sciences and Fisheries Abstracts (ASFA)

UDK 5 Letnik 18, Koper 2008, številka 1 ISSN 1408-533X

VSEBINA / INDICE GENERALE / CONTENTS

Original scientific article
Received: 2008-04-04

UDC 597.556.255(262.16)

THE SYNGNATHID SPECIES FROM TUNISIAN WATERS (CENTRAL MEDITERRANEAN): A SURVEY

Mohamed Mourad BEN AMOR & Mohamed BEN SALEM
Unité de Recherches Zoologie et Écologie des Milieux Aquatiques, Faculté des Sciences, Campus universitaire,
Le Belvédère, 1060 Tunis, Tunisie
E-mail: benamor7@yahoo.fr

Jamila BEN SOUISSI
Département des Ressources animales, halieutiques et des Technologies Agroalimentaires, Institut National Agronomique de Tunisie,
1082 Tunis, 43 avenue Charles Nicolle, cité Mahrajène, Tunisie

Christian REYNAUD & Christian CAPAPÉ
Laboratoire d'Ichtyologie, case 104, Université Montpellier II, Sciences et Techniques du Languedoc, 34095 Montpellier cedex 05, France

ABSTRACT

Seven syngnathid species have been recorded to date in Tunisian waters: the short-snouted seahorse Hippocampus hippocampus *(Linnaeus 1758), the long-snouted seahorse* H. ramulosus *Leach, 1814; the straight-nosed pipefish* Nerophis ophidion *(Linnaeus 1758), the black-striped pipefish* Syngnathus abaster *Risso 1826, the greater pipefish* S. acus *Linnaeus 1758, the deep-snouted pipefish* S. typhle *Linnaeus 1758 and Nilsson's pipefish* S. rostellatus *Nilsson 1855. Description, main morphometric measurements, counts, habitat and distribution are presented and commented for each species. They have been found mainly in estuarine and brackish waters, such as Bizerte Lagoon, Tunis Southern Lagoon and in the Bahiret El Biban. Both seahorses seem to be more frequent in the Tunisian waters that the 5 other syngnathid species, probably due to fact that the former constitute the focus of intense fishery, while the latter are generally discarded at sea by fishermen.*

Key words: Osteichthyes, Syngnathidae, Tunisian waters, Central Mediterranean

INDAGINE SULLE SPECIE DI SIGNATIDI IN ACQUE TUNISINE (MEDITERRANEO CENTRALE)

SINTESI

Sette specie di signatidi sono state confermate per le acque tunisine: il cavalluccio marino Hippocampus hippocampus *(Linnaeus 1758), il cavalluccio camuso* H. ramulosus *Leach, 1814; il pesce ago sottile* Nerophis ophidion *(Linnaeus 1758), il pesce ago di rio* Syngnathus abaster *Risso 1826, il pesce ago* S. acus *Linnaeus 1758, il pesce ago cavallino* S. typhle *Linnaeus 1758 ed il pesce ago di Nilsson* S. rostellatus *Nilsson 1855. L'articolo riporta la descrizione, le principali misure morfometriche, il numero di individui, l'habitat e la distribuzione per ogni singola specie. Gli esemplari sono stati raccolti principalmente negli estuari ed in acque salmastre, quali la Laguna di Bizerte, la Laguna meridionale di Tunisi e il Bahiret El Biban. Entrambe le specie di cavallucci appaiono più frequenti in acque tunisine che non le cinque specie di pesce ago, probabilmente perchè i cavallucci vengono intensamente pescati, mentre i pesci ago vengono rigettati in mare dai pescatori.*

Parole chiave: Osteichthyes, Syngnathidae, acque tunisine, Mediterraneo centrale

INTRODUCTION

Syngnathid species, sea-horses and pipe-fishes are widely distributed and their occurrence has been reported in marine, brackish and freshwater areas. In all, 232 species have been recorded throughout the world (Dawson, 1982; Whitfield, 1995; Lourie *et al.*, 1999). Of the 17 syngnathid species known from the Mediterranean (Dawson, 1985; Lourie *et al.*, 1999), 7 have been recorded in Tunisian waters (Bradaï *et al.*, 2004; Ben Amor *et al.*, 2006, 2007a, b, 2008): the short snouted seahorse *Hippocampus hippocampus* (Linnaeus 1758), the long-snouted seahorse *Hippocampus ramulosus* Leach, 1814, the straight-nosed pipefish *Nerophis ophidion* (Linnaeus 1758), the black-striped pipefish *Syngnathus abaster* Risso 1826, the greater pipefish *Syngnathus acus* Linnaeus 1758, the deep-snouted pipefish *Syngnathus typhle* Linnaeus 1758, and Nilsson's pipefish *Syngnathus rostellatus* Nilsson 1855.

In the present article, 7 Tunisian syngnathid species are presented, including a description based on specimens collected during the investigations conducted in the area since 2000, and we comment on the local distribution of these species, compared and contrasted with other Mediterranean areas. Syngnathids are close to being threatened (Lourie *et al.*, 1999), and as the species occurring in Tunisian waters have been poorly studies, we have attempted to assess the real status of these species in the region and, concomitantly, to establish a national plan for their protection in the same region as well.

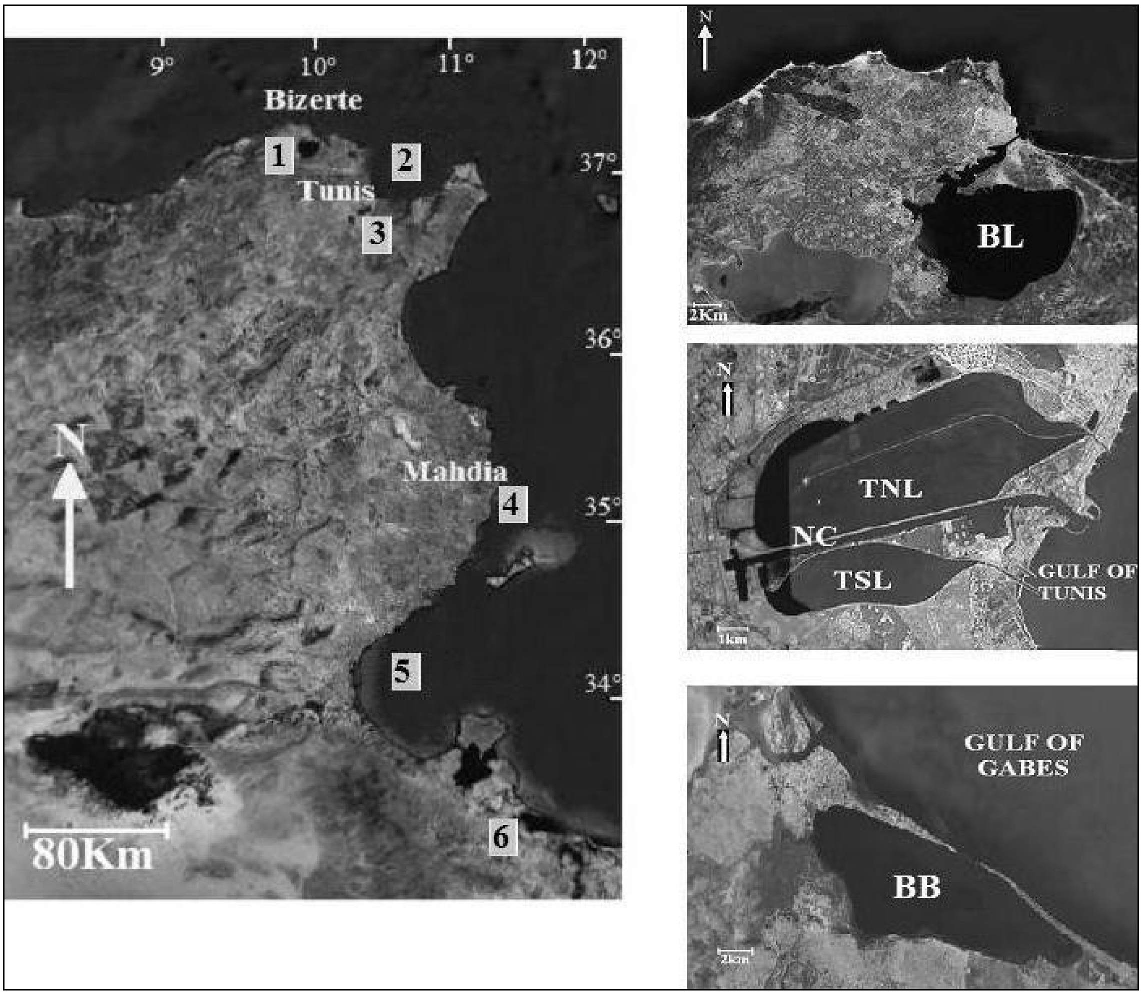


Fig. 1: Map of Tunisia showing the capture sites of syngnathid species in Tunisian waters: 1 – Bizerte Lagoon (BL); 2 – Gulf of Tunis; 3 – Tunis Northern Lagoon (TNL) and Tunis Southern Lagoon (TSL) separated by navigation channel (NC); 4 – Off Mahdia; 5 – Gulf of Gabès; 6 – Bahiret El Biban (BB).

Sl. 1: Zemljevid Tunizije in njenega teritorialnega morja z označenimi lokalitetami, na katerih so bile ulovljene različne vrste morskih konjičkov in šil: 1 – Laguna Bizerte (BL); 2 – Tuniški zaliv; 3 – Tuniška severna laguna (TNL) in Tuniška južna laguna (TSL), ki ju loči kanal za ladijsko plovbo (NC); 4 – Mahdijske vode; 5 – Gabeški zaliv; 6 – Bahiret El Biban (BB).

MATERIAL AND METHODS

Investigations were conducted between 2000 and 2005 at fish landings located along the Tunisian coast and close to brackish areas such as Bizerte Lagoon, Tunis Southern Lagoon and the Bahirat El Biban (Fig. 1). Observations were carried out at least three times per month. The observed specimens were caught by commercial gill-nets with 22 mm mesh size, off the Tunisian coast. Concomitantly, experimental samplings were carried out monthly to explore both shallow coastal and lagoon brackish waters, using landing net, with 2 mm mesh size, experimental mobile fishing gear (dredging) and SCUBA diving. All studied specimens are preserved in 5% buffered formalin solution and deposited in the Ichthyological Collection of the Faculté des Sciences of Tunis. We have also examined specimens preserved in the Ichthyological collection of the Museum National d'Histoire Naturelle (MNHN) of Paris and the British Natural History Museum (BMNH) in London. The specimens were measured and meristic counts carried out following the protocol defined for sea-horses by Lourie *et al.* (1999) and for pipefishes by Dawson (1982). Methods of measurements are plotted in Figure 2 for sea-horses, and in Figures 3 and 4 for pipefishes.

RESULTS AND DISCUSSION

Genus *Hippocampus* Rafinesque, 1810

Hippocampus hippocampus (Linnaeus, 1758) (Fig. 5A)

Material. A total of 236 examined specimens, 158 males and 78 females, were collected in the Lagoon of Bizerte. Males ranged between 83 mm and 156 mm in total length, females between 74 mm and 138 mm. In addition, 4 specimens from MNHN in Paris were also examined.

Description. Wedge-shaped coronet with five rounded knobs. Snout short with poor developed nose spine. Inconspicuous spines and tips. Cutaneous filaments rudimentary or lacking. Head-length 1.31–2.17 in pre-anal length, 4.69–6.71 in total-length; snout-length 1.65–4.28 in head-length; eye rounded 3.89–8.13 in head length; pre-orbital length 1.9–2.76 in head-length; post-orbital length 2.05–2.75 in head-length; pre-dorsal length 2.86–5.0 in total-length; dorsal length 0.58–0.77 in dorsal base; dorsal fin slender with 14–22 soft rays; pectoral with 12–17 soft rays; anal with 3–5 soft rays; 12–13 trunk rings before anus; 31–32 tail rings; 43–45 total rings. Colour brownish to darkish, white spots lacking, some specimens sometimes lighter or reddish. Dorsal greyish with large strip.

Distribution. Although *H. hippocampus* occurs in temperate and warm temperate waters, it has been reported from the North Sea, the Channel and from off the eastern Atlantic from the Bay of Biscay to the Gulf of Guinea. *H. hippocampus* occurs throughout the Mediterranean, in the Adriatic and Black Seas (Bauchot & Pras, 1980; Dawson, 1986; Fredj & Maurin, 1987). In Tunisian waters, *H. hippocampus* has been reported from their northern areas by Azzouz (1971, 1974) and

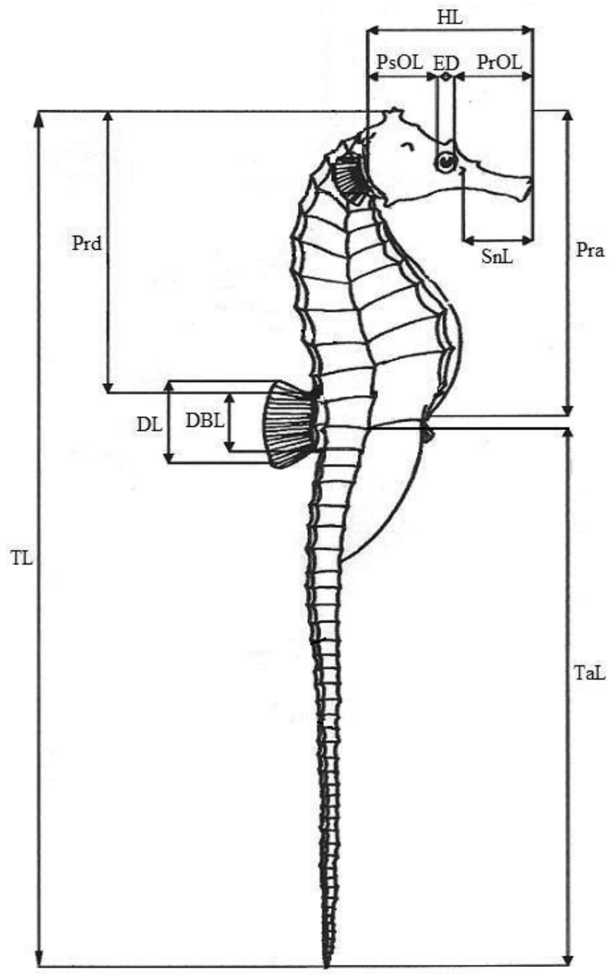


Fig. 2: Measurements carried out on genus** Hippocampus **(specimen redrawn from Lourie** et al. **(1999)). Legend: DBL – dorsal fin base length; DL – dorsal fin length; ED – eye diameter; HL – head length; Pra – pre-anal fin distance; Prd – pre-dorsal fin distance; PrOL – pre-orbital length; PsOL – post-orbital length; SnL – snout length; TaL – tail length; TL – total length.

Sl. 2: Izmere, napravljene na rodu** Hippocampus **(primerki prerisani po Lourieju** et al. **(1999)). Legenda: DBL – osnova hrbtne plavuti; DL – dolžina hrbtne plavuti; ED – premer očesa; HL – dolžina glave; Pra – dolžina od vrha glave do začetka zadnjične plavuti; Prd – dolžina od vrha glave do začetka hrbtne plavuti; PrOL – preorbitalna dolžina; PsOL – postorbitalna dolžina; SnL – dolžina gobca; TaL – dolžina repa; TL – celotna dolžina.

Bradaï *et al.* (2004), and from the south of the Gulf of Gabès by Vinciguerra (1882–1883, 1884), Ben Othman (1971, 1973) and Bradaï *et al.* (2004). We found *H. hippocampus* only in the northern Bizerte Lagoon.

Habitat. According to Tortonese (1970) and Bauchot & Pras (1980), *H. hippocampus* inhabits sandy bottoms between 0 and 30 m, rich in organic nutriments, as well as sea grass beds where it seeks for shelter and food.

While Bradaï (2000) noted that the species was common in Tunisian waters, we have found rather uncommon in the region, possibly due both to over-fishing and pollution (Lourie *et al.*, 1999). According to Tortonese (1970) and Lourie *et al.* (1999), a single population may occur in the Mediterranean and in the eastern Atlantic. In the Red Sea, *H. hippocampus* has been replaced by *H. fuscus*, which entered the Mediterranean Sea through the Suez Canal and has been recorded by Golani & Fine (2002) off the Mediterranean coast of Israel and by Gokoglu *et al.* (2004) off the Turkish coast. Additionally, a species closely related to *H. fuscus* has been recorded in Tunisian waters, but further identification is needed for confirmation.

Hippocampus ramulosus **Leach, 1814 (Fig. 5B)**

Material. A total of 1773 specimens, 897 males and 876 females, were collected in the northern areas, such as Bizerte Lagoon, in the Gulf of Tunis, and southward off Mahdia and in the Gulf of Gabès. Males ranged between 63 mm and 176 mm in total length, females between 70 mm and 170 mm. Additionally, 64 specimens from the MNHN in Paris were examined.

Description. Snout long, spines, knobs and tips well developed. Filaments thick and branched, mainly on head and coronet. Head-length 1.02–2.33 in pre-anal length, 4.27–7.31 in total-length; snout-length 1.26–3.71 in head-length; eye rounded 3.69–8.16 in head length; pre-orbital length 1.65–8.88 in head-length; post-orbital length 2.06–3.13 head-length; pre-dorsal length 2.77–5.87 in total-length; dorsal length 0.51–0.93 in dorsal base; dorsal fin slender with 14–23 soft rays; pectoral with 12–19 soft rays; anal with 3–5 soft rays; 12–13 trunk rings before anus; 29–34 tail rings; 41–46 total rings. Brownish variable to greenish with white spots. Large brownish strip on dorsal.

Distribution. H. ramulosus occurs off the eastern Atlantic from the British Isles to Morocco and around Madeira and Azores (Dawson, 1986), throughout the Mediterranean and in the Black Sea. In Tunisian waters, *H. ramulosus* has previously been reported from the Gulf of Gabès (Ben Othman, 1973; Bradaï *et al.*, 2004). We have collected specimens from both northern and southern Tunisian coast, such as in the Gulf of Tunis, Gulf of Gabès, and off Mahdia. *H. ramulosus* successfully entered the Bizerte Lagoon.

Habitat. H. ramulosus inhabits shallow coastal and brackish waters (Bauchot & Pras, 1980; Lourie *et al.*, 1999), sandy-muddy bottoms and/or sea grass beds covered by marine phanerogams and algae.

In Tunisian waters, *H. ramulosus* has been more frequently observed than its close relative species. The phenomenon could possibly be the result of interspecific competition between both species. *H. ramulosus* reaches a larger size and is consequently more abundant in reduced areas, while in larger areas, such as the Bizerte Lagoon, it coexists with it.

Genus *Nerophis* Rafinesque, 1810

Nerophis ophidion **(Linnaeus, 1758) (Fig. 5C)**

Material. We have examined 14 female specimens collected in the Bahiret El Biban, ranging between 159 mm and 166 mm in total length. In addition, twenty-five specimens from the MNHN in Paris were also examined.

Description. Body elongate, rounded, smooth without spines; head slender rather prominent, head-length 4.8–7.5 in pre-anal fin length, 14.0–17.4 in total length; snout slightly stout rounded at distal end with a slight large coronet, snout-length 2.2–3.0 in head-length; eye rounded 4.5–7.2 in head-length; pre-orbital length 1.7–2.5 in head-length; post-orbital length 1.7–2.7 in head-length; pre-dorsal fin length 2.4–3.4 in tail length; dorsal fin slender with 30–36 soft rays on 11–12 rings; dorsal fin length 7.9–10.1 in total length and 1.1 approximately in dorsal fin base; anus located at mid-part of dorsal fin base; 11–12 under dorsal rings, 28 trunk rings, 65–68 tail rings, 104–108 total rings. Colour greenish to brownish, with lateral edges rather darkish; black and white notches on head.

Distribution. According to Bauchot & Pras (1980), *N. ophidion* is widely distributed in the Eastern Atlantic from Norway to Morocco (excluding the region from Denmark to Netherlands), as well as throughout the Mediterranean and the Black Sea. Dieuzeide *et al.* (1954) reported *N. ophidion* off the Algerian coast. By contrast, *N. ophidion* has not been recorded off Libya (Al Hassan & El Silini, 1999) and off the Mediterranean coast of Egypt (El Sayed, 1994). Golani (2005), however, reported on *N. ophidion* from off the Mediterranean coast of Israel.

Habitat. According to Bauchot & Pras (1980), Pérès & Picard (1964), *N. ophidion* is a sedentary species inhabiting sea-grass beds and herbaria at depths between 10 and 15 m, and is known to have entered various lagoons. The species has probably found favorable environmental conditions in the Bahiret El Biban, which could explain its occurrence in the area.

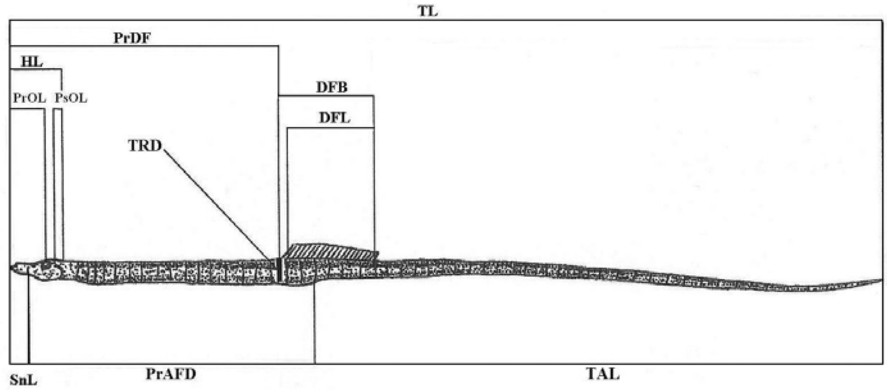


Fig. 3: Measurements carried out on genus* Nerophis *(specimen redrawn from Nijssen & Buizer (1983)). Legend: DFB – dorsal fin base; DFL – dorsal fin length; ED – eye diameter; HL – head length; PrAFD – pre-anal fin distance; PrDF – pre-dorsal fin distance; PrOL – pre-orbital length; PsOL – post-orbital length; SnL – snout length; TAL – tail length; TL – total length; TRD – trunk depth.
Sl. 3: Izmere, napravljene na rodu* Nerophis *(primerki prerisani po Nijssen & Buizer (1983)). Legenda: DFB – osnova hrbtne plavuti; DFL – dolžina hrbtne plavuti; ED – premer očesa; HL – dolžina glave; PrAFD – dolžina od vrha glave do začetka zadnjične plavuti; PrDF – dolžina od vrha glave do začetka hrbtne plavuti; PrOL – preorbitalna dolžina; PsOL – postorbitalna dolžina; SnL – dolžina gobca; TAL – dolžina repa; TL – celotna dolžina; TRD – globina trupa.

Dawson (1986) wrongly noted the occurrence of *N. ophidion* in Tunisian waters, from where the species has never been reported according to Bradaï (2000) and Bradaï *et al.* (2004). The first findings of *N. ophidion* in the area were reported by Ben Amor *et al.* (2007a).

Genus *Syngnathus* Linnaeus, 1758

***Syngnathus abaster* Risso, 1810 (Fig. 5D)**

Material. A total of 104 Tunisian specimens, 40 males and 64 females, have been examined. They were collected in the Tunis Southern Lagoon and in the Navigation Channel of Halq El Oued. Males ranged between 74 mm and 198 mm in total length, females between 70 mm and 174 mm. Twenty-seven specimens from MNHN in Paris have also been examined.

Description. Body elongate, rounded rather prominent, head-length 2.32–4.81 in pre-anal length, 5.35–12.80 in total-length; snout slightly rounded without knobs, but with an inconspicuous keel on upper surface, snout-length 1.50–5.67 in head-length; eye rounded and minute, 3.71–8.86 in head-length; pre-orbital length 1.22–2.75 in head-length; post-orbital length 1.59–3.31 in head-length; pre-dorsal length 2.20–2.96 in total-length; dorsal base 7.02–14.06 in total length, dorsal length 0.76–0.98 in dorsal base; pre-anal length 2.05–3.02 in total-length; dorsal fin slender with 16–35 soft rays on 5–7 rings; pectoral with 10–16 soft rays; anal with 3–4 soft rays; caudal with 9–13 soft rays; anus located under the beginning of the dorsal fin; 14–18 trunk rings before anus, 24–37 tail rings, 39–53 total rings. Colour greenish to brownish or reddish, body with white lines and spots, snout rather brownish, with a blackish spot before eyes, black spots arranged in a line under the dorsal base. Belly whitish or beige.

Distribution. S. abaster had previously been recorded throughout the southern coast of the Mediterranean: off Algeria (Dieuzeide *et al.*, 1954), Libya (Al Hassan & El Silini, 1999), Egypt (El Sayed, 1994) and Israel (Golani, 2005). Our investigations showed that the species was being caught mainly in the northern areas, such as Tunis Southern Lagoon, which is in agreement with Chaouachi & Ben Hassine (1998). Rare specimens had been caught southward (D'Ancona, 1934; Seurat, 1934). Bradaï (2000), for instance, reported the capture of a single specimen in the Gulf of Gabès.

Habitat. Dawson (1982, 1986) noted that the straight-nosed pipefish inhabited shallow coastal waters and estuaries, usually at 4–20 m. The recent environmental restoration of the Tunis Southern Lagoon allowed a colonization of fish species previously unknown in the area, including *S. abaster*. In the area, the species found sufficient resources to live as well as to possibly develop and reproduce there.

The records of *S. abaster* in Tunisian waters have shown that it inhabits protected areas. Outside such areas, the species has been subjected to severe competition pressure, both inter and intra specific. Additionally, the specimens captured by craft fishery and/or by trawls were discarded at sea.

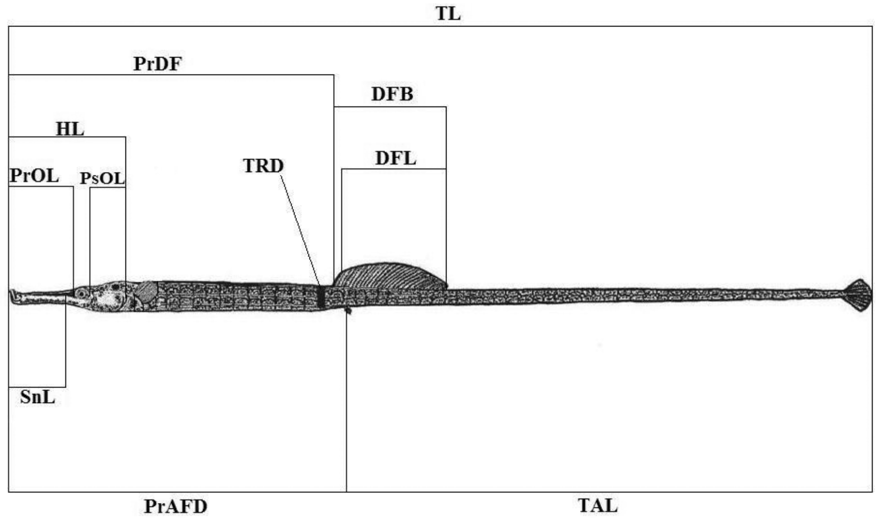


Fig. 4: Measurements carried out on genus** Syngnathus **(specimen redrawn from Tortonese (1970)). Legend: see Figure 3.
Sl. 4: Izmere, napravljene na rodu** Syngnathus **(primerki prerisani po Tortoneseju (1970)). Legenda: glej sliko 3.

Syngnathus acus **Linnaeus, 1758 (Fig. 5E)**

Material. A total of 267 specimens have been examined: 92 males and 175 females. They were collected in the Tunis Southern Lagoon, in the Gulf of Tunis and in the Bahiret El Biban. Males ranged between 74 mm and 199 mm in total length, females between 71 mm and 207 mm. In addition, 30 specimens from MNHN in Paris have also been examined.

Description. Body elongate, snout slightly compressed with inconspicuous medial ridge, eyes round. Head-length 2.32–4.74 in pre-anal length, 5.35–11.28 in total-length; snout-length 1.70–3.41 in head-length; eye rounded and minute, 3.70–9.06 in head-length; pre-orbital length 1.42–2.94 in head-length; post-orbital length 1.59–3.34 in head-length; pre-dorsal length 2.20–2.79 in total-length; dorsal base 7.78–14.54 in total length; dorsal length 0.86–0.99 in dorsal base; dorsal fin slender with 22–35 soft rays; pectoral with 11–16 soft rays; anal with 3–4 soft rays; caudal with 9–13 soft rays; 14–18 trunk rings before anus; 27–47 tail rings, 41–63 total rings. Colour greyish, brown, yellowish, marking variable. Belly whitish or beige.

Distribution. According to Bauchot & Pras (1980), *S. acus* is an Atlantic-Mediterranean species known from Morocco to Norway, in the Mediterranean, in the Adriatic and Black Seas (Tortonese, 1970; Dawson, 1986; Fredj & Maurin, 1987). The species is known from south of the Strait of Gibraltar to South Africa (Dawson, 1986). It has also been reported from off China and Indonesia, from off the northern Tunisian coast (Azzouz, 1971, 1974) and the Gulf of Gabès (Ben Othman, 1971, 1973; Bradaï *et al.*, 2004). We have recorded *S. acus* in the Gulf of Tunis, in the Tunis Southern Lagoon, and in the Bahiret El Biban.

Habitat. S. acus preferentially inhabits shallow coastal and estuarine waters, rarely brackish waters to 50m depth and probably more (Bauchot & Pras, 1980; Nijssen & Buizer, 1983; Dawson, 1985). It is found on sandy and muddy as well as detritic bottoms. The Tunisian specimens were caught on sea grass beds, including *Posidonia oceanica* and some algae species such as *Caulerpa prolifera, C. racemosa, Cystoseira stricta, C. crinita* and *Rythiphlaea tinctoria*.

S. acus is the most common syngnathid species. It is probably able to develop and reproduce more easily than its congeneric species, possibly due to the fact that it prefers to inhabits detritic shallow coastal waters and sea grass beds, where it is able to avoid both fishing and competition pressures.

Syngnathus rostellatus **Nilsson, 1855 (Fig. 5F)**

Material. The single examined specimen was collected in the Gulf of Tunis. It has been deposited in the Ichthyological Collection of the Faculté des Sciences of Tunis (reference FST-SYN-rostellatus-01) and compared with seven specimens from the BMNH in London.

Description. Body elongate, rounded slightly compressed, head rather prominent, head-length 2.77 in pre-anal length, 6.72 in total length; snout elongate and compressed; mouth without true teeth, small, and terminal on a protruding cylindrical snout narrow and tubular and with a keel on upper surface, snout-length 1.9 in head length; post-orbital length 3.02 in head-length; pre-dorsal length 2.52 in total length; dorsal fin slender with 35 soft rays on 9 rings; dorsal base 9.95 in total length; 18 trunk rings; 39 tail rings; 57 total rings; pectoral with 12 soft rays; anal with 4 soft rays; caudal with 11 soft rays. Colour greyish to brownish, with darkish bars on

dorsal and flanks. Belly beige with silvery sheen on head and trunk. Dorsal fin hyaline. Its total length is 211 mm.

Distribution. Syngnathus rostellatus was reported from off the eastern Atlantic coast off Norway and the British Isles (Wheeler, 1969), from the Bay of Biscay (Bauchot & Pras, 1980) and from off the coast of Portugal (Albuquerque, 1954–1956). In contrast, the species has not been known to occur south of the Strait of Gibraltar (Dawson, 1986). *S. rostellatus* had previously been recorded three times only in the Mediterranean Sea, in the Alboran Sea (southern Spain) by Reina-Hervas *et al.* (1981–1982), off Banyuls (Gulf of Lions, southern France) by Louisy (2002), and off the Anatolian coast (southern Turkey) by Gokoglu *et al.* (2004).

Habitat. Vincent *et al.* (1995) noted that *S. rostellatus* occurs in "sandy areas and shallow seagrass beds, lying on the bottom or aligned with the eelgrass". They added that the specimens were "cryptic in either case".

The recovery of *S. rostellatus* is the first from Tunisian waters and the fourth from the Mediterranean Sea. Altogether, six specimens were recorded by Reina-Hervàs (1989) in the Alboran Sea. The Spanish records of *S. rostellatus* could be explained by the vicinity of the Atlantic. The specimens easily entered the Alboran Sea through the Strait of Gibraltar. Off Banyuls, Louisy (2002) recorded a single female, while off Turkey, Gokoglu *et al.* (2004) observed 4 specimens. They occurred in waters warmer than those usually required by the species. The absence of *S. rostellatus* during more than twenty years in Mediterranean areas between Spain and other Mediterranean areas could be explained by misidentification with its close relative species. Additionally, the syngnathids have not been subjected to a thorough research and have been generally discarded at sea by fishermen due to their low economic value.

***Syngnathus typhle* Linnaeus, 1758 (Fig. 5G)**

Material. Thirty female specimens, caught in the Bahiret El Biban and ranging between 153 mm and 307 mm in total length were examined. In addition, we have examined 61 specimens from the MNHN in Paris.

Description. Body elongate, rounded; head rather prominent, head-length 2.3–4.8 in pre-anal length, 4.8–6.8 in total length; snout compressed rather strait and with a keel on upper surface, snout-length 1.2–2.2 in head-length; eye rounded and minute 8.3–13.8 in head-length; pre-orbital 1.3–1.7 in head-length; post-orbital length 1.4–4.7 in head-length; pre-dorsal length 1.8–2.5 in total-length; dorsal fin slender with 29–39 soft rays on 8 rings; dorsal-base 5.8–12.6 in total-length; 18 trunk rings; 30–32 tail rings; 56–58 total rings, pectoral with 13–19 soft rays; anal with 3–4 soft rays; caudal with 8–13 soft rays. Colour greenish to olivaceous, snout with dark lines and spots. Belly whitish or argenteous.

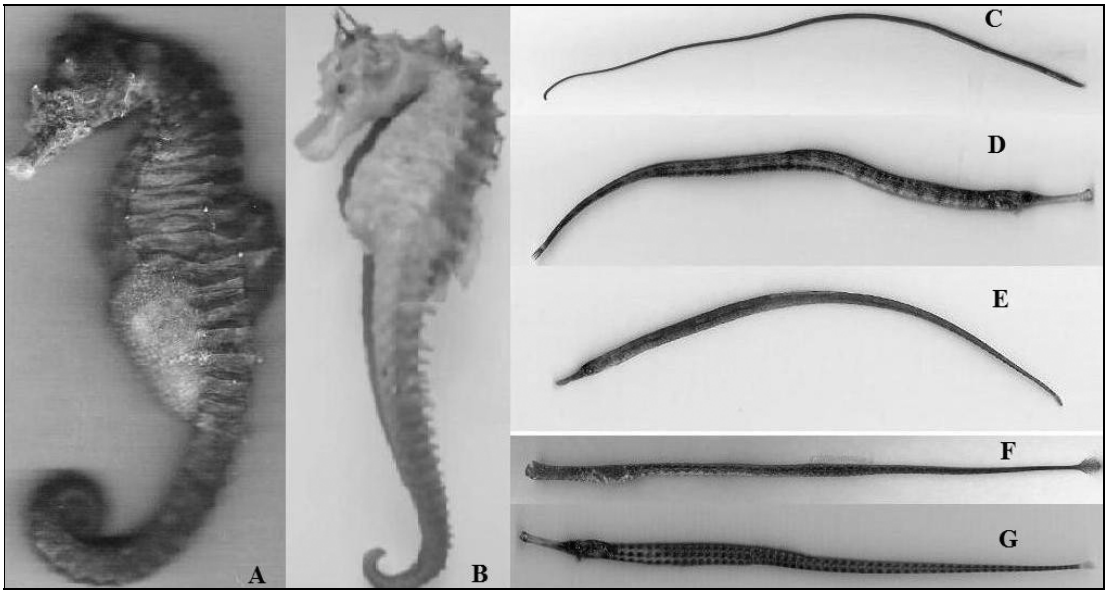


Fig. 5: Syngnathid species found in Tunisian waters. (A) *Hippocampus hippocampus* ***(Linnaeus, 1758); (B)*** *H. ramulosus* ***Leach, 1814; (C)*** *Nerophis ophidion* ***(Linnaeus, 1758); (D)*** *Syngnathus abaster* ***Risso, 1810; (E)*** *S. acus* ***Linnaeus, 1758; (F) S.*** *typhle* ***Linnaeus, 1758; (G)*** *S. rostellatus* ***Nilsson, 1855.***
Sl. 5: Vrste morskih konjičkov in šil, ki so jih avtorji zabeležili v tunizijskih vodah. (A) *Hippocampus hippocampus* ***(Linnaeus, 1758); (B)*** *H. ramulosus* ***Leach, 1814; (C)*** *Nerophis ophidion* ***(Linnaeus, 1758); (D)*** *Syngnathus abaster* ***Risso, 1810; (E)*** *S. acus* ***Linnaeus, 1758; (F)*** *S. typhle* ***Linnaeus, 1758; (G)*** *S. rostellatus* ***Nilsson, 1855.***

Distribution. S. typhle is known to occur off the eastern Atlantic coast from Scandinavia to Morocco (Bauchot & Pras, 1980; Dawson, 1986; Riedel, 1991), throughout the Mediterranean, in the Adriatic and Black Seas. From Tunisian waters, it had formerly been reported by D'Ancona (1934), Tortonese, (1970), mainly from the Gulf of Gabès (Seurat, 1934), by Bradaï (2000) and Bradaï *et al.* (2004); unfortunately no specimen has been available for confirmation. The recent work by Ben Amor *et al.* (2007b) reports on captures in the Tunis Southern Lagoon and in the Bahiret El Biban, with these findings confirming the occurrence of *S. typhle* in Tunisian waters.

Habitat. According to Dawson (1986), *S. typhle* inhabits mainly shallow coastal and estuarine waters between 4 and 20 m depth. It occurs on sandy and muddy bottoms, as well as in sea grass beds.

Although *S. typhle* seems to be rather rare in the areas from which the species has been reported, Tortonese (1970) found changes in morphological characters between juveniles and adults, and males and females; consequently, the species diagnosis remains somewhat difficult. *S. typhle* is larger and lives at lower depths than its congeneric species, which makes it sensible to fishing pressure. The species presents no economical interest and it is discarded at sea by fishermen soon after capture.

CONCLUSIONS

The seven syngnathid species are not equally distributed in Tunisian waters. The long-snouted sea-horse *Hippocampus ramulosus* was the most frequently observed species; in contrast, we have collected a single Nilsson's pipefish *Syngnathus rostellatus*, locally recorded for the first time and for the fourth time in the entire Mediterranean area.

Globally, the two sea-horse species seemed to be more common than the five other pipefish species. The former are well known by fishermen and constitute the focus of intense fishery for medicines, aquarium fishes and curiosities for tourists as in other marine regions throughout the world. In northern Tunisian areas, for instance, they are targeted by fishermen throughout the year. The latter are by-catch species, without commercial value, and are generally discarded at sea by fishermen. Additionally, for a non-specialist it is not very easy to distinguish syngnathid species between them.

Of the 17 syngnathid species recorded in the Mediterranean, only 7 occur in Tunisian waters. Consequently, other recoveries of syngnathid species in the area could not be excluded due to migrations inside the Mediterranean Sea, but also outside the Red Sea through the Suez Canal and the eastern Atlantic through the Strait of Gibraltar.

ACKNOWLEDGEMENTS

The authors wish to thank two referees for providing useful and helpful suggestions that allowed improving the ms.

PREGLED MORSKIH KONJIČKOV IN ŠIL (SYNGNATHIDAE) V TUNIZIJSKIH VODAH (OSREDNJE SREDOZEMLJE)

Mohamed Mourad BEN AMOR & Mohamed BEN SALEM
Unité de Recherches Zoologie et Écologie des Milieux Aquatiques, Faculté des Sciences, Campus universitaire, Le Belvédère, 1060 Tunis, Tunisie
E-mail: benamor7@yahoo.fr

Jamila BEN SOUISSI
Département des Ressources animales, halieutiques et des Technologies Agroalimentaires, Institut National Agronomique de Tunisie, 1082 Tunis, 43 avenue Charles Nicolle, cité Mahrajène, Tunisie

Christian REYNAUD & Christian CAPAPÉ
Laboratoire d'Ichtyologie, case 104, Université Montpellier II, Sciences et Techniques du Languedoc, 34095 Montpellier cedex 05, France

POVZETEK

V tunizijskih vodah je bilo doslej ugotovljenih sedem vrst iz družine morskih konjičkov in šil: kratkonosi morski konjiček Hippocampus hippocampus *(Linnaeus 1758) in dolgonosi morski konjiček* H. ramulosus *Leach, 1814; kačje šilo* Nerophis ophidion *(Linnaeus 1758), malo šilo* Syngnathus abaster *Risso 1826, veliko šilo* S. acus *Linnaeus*

1758, ploskonoso šilo S. typhle *Linnaeus 1758 in šilo vrste* S. rostellatus *Nilsson 1855. Opisane so vse zabeležene vrste, skupaj z njihovimi glavnimi morfometričnimi dimenzijami, številom preštetih osebkov, habitatom in razširjenostjo. Vrste so bile najdene predvsem v obrežnih in brakičnih vodah v območjih, kot so Laguna Bizerte, južna tuniška laguna in Bahiret El Biban. Obe vrsti morskih konjičkov se v tunizijskih vodah zdita pogostejši kot pet vrst morskih šil, bržkone zaradi dejstva, da konjička tvorita žarišče intenzivnega ribištva, medtem ko šila ribiči večinoma zavržejo že na morju.*

Ključne besede: Osteichthyes, Syngnathidae, tunizijske vode, osrednje Sredozemlje

REFERENCES

Albuquerque, R. M. (1954–1956): Peixes de Portugal e ilhas adjacentes. Chaves para a sua determinaçao. Port. Acta Biol. B, 5, 1–1164.

Al Hassan, L. A. J. & O. A. El Silini (1999): Check-list of bony fishes collected from the Mediterranean coast of Bengazi, Libya. Rev. Biol. Mar. Oceanogr., 34(2), 291–301.

Azzouz, A. (1971): Etude des biocénoses benthiques et de la faune Ichthyologique des fonds chalutables de la Tunisie. Thèse Sci. Nat. Caen. A. O. 6472, 143 p.

Azzouz, A. (1974): Les fonds chalutables de la région nord de la Tunisie. 2. Potentialités de la pêche, écologie et répartition bathymétrique des poissons. Bull. Inst. Natl. Sci. Tech. Oceanogr. Peche Salammbô, 3(1–4), 29–94.

Bauchot, M. L. & A. Pras (1980): Guide des poissons marins d'Europe. Delachaux & Niestlé, Lausanne-Paris, 427 p.

Ben Amor, M. M., M. Ben Salem, J. Ben Souissi & C. Capapé (2006): Observation on the black-striped pipefish, *Syngnathus abaster* Risso, 1810 (Osteichthyes: Syngnathidae) from the Tunisian waters (central Mediterranean). Annales, Ser. Hist. Nat., 16(2), 193–198.

Ben Amor, M. M., J. Ben Souissi, M. Ben Salem & C. Capapé (2007a): Confirmed occurrence of the straight-nosed pipefish, *Nerophis ophidion* (Syngnathidae) in southern Tunisia (central Mediterranean). Cybium, 31(4), 483–484.

Ben Amor, M. M., M. Ben Salem, J. Ben Souissi & C. Capapé (2007b): On the occurrence of the deep-snouted pipefish *Syngnathus typhle* Linnaeus, 1758 (Osteichthyes: Syngnathidae) in the Tunisian waters (Central Mediterranean). Acta Adriat., 48(1), 15–23.

Ben Amor, M. M., M. Ben Salem, J. Ben Souissi & C. Capapé (2008): Occurrence of the Nilsson's pipefish, *Syngnathus rostellatus* in the Gulf of Tunis (central Mediterranean). Vie Milieu. *(in press)*

Ben Othman, S. (1971): Etude préliminaire sur l'ichthyologie du Sud tunisien. Rapp. Comm. int. Mer Médit., 20(3), 443–444.

Ben Othman, S. (1973): Le sud tunisien (golfe de Gabès): hydrologie, Sédimentologie, flore et faune. Thèse de spécialité. Fac. Sciences, Univ. Tunis (Tunisie), 166 p.

Bradaï, M. N. (2000): Diversité du peuplement ichtyque et contribution à la connaissance des sparidés du golfe de Gabès. Ph. D. Thesis. University of Sfax (Tunisia), 600 p.

Bradaï, M. N., J. P. Quignard, A. Bouaïn, O. Jarboui, A. Ouannes-Ghorbel, L. Ben Abdallah, J. Zaouali & S. Ben Salem (2004): Ichtyofaune autochtone et exotique des côtes tunisiennes: recensement et biogéographie. Cybium, 28(4), 315–328.

Chaouachi, B. & O. K. Ben Hassine (1998): The status of fish biodiversity in Ichkeul Lagoon, Tunisia. Ital. J. Zool., suppl., 303–304.

D'Ancona, U. (1934): Le specie mediterranee del genere *Syngnathus*. Mem. R. Com. Talassogr. Ital., 1–79.

Dawson, C. E. (1982): Fishes of western north Atlantic. Part 8 Order Gasterosteiformes, Suborder Syngnathoidei, Syngnathidae. Sears Foundation for Marine Research Memoir (Yale University), 1, 1–197.

Dawson, C. E. (1985): Indo-Pacific pipefishes (Red sea to the Americas). Gulf Coast Research Laboratory, Ocean Springs, Mississipi, USA, 217 p.

Dawson, C. E. (1986): Syngnathidae. In: Whitehead, J. P., M. L. Bauchot, J. C. Hureau, J. Nielsen & E. Tortonese (eds.): Fishes of the North-western Atlantic and the Mediterranean, Vol. I. UNESCO, Paris, pp. 628–639.

Dieuzeide, R., M. Novella & J. Roland (1954): Catalogue des poissons des côtes algériennes. Bull. Stn. Aquic. Pêche Castiglione, n. s., 6, 1–384.

El Sayed, R. S. (1994): Check-list of Egyptian Mediterranean fishes. Institute of Oceanography and Fisheries, Alexandria, Egypt, 77 p.

Fredj, G. & C. Maurin (1987): Les poissons dans les banques de données Médifaune. Application à l'étude des caractéristiques de la faune ichtyologique méditerranéenne. Cybium, 11(3), 218–299.

Gokoglu, M., T. Bodur & Y. Kaya (2004): First records of *Hippocampus fuscus* and *Syngnathus rostellatus* (Osteichthyes: Syngnathidae) from the Anatolian coast (Mediterranean Sea). J. Mar. Biol. Ass. U. K., 84, 1094–1096.

Golani, D. (2005): Checklist of the Mediterranean Fishes of Israel. Zootaxa, 947, 1–90.

Golani, D. & M. Fine (2002): On the occurrence of *Hippocampus fuscus* in the eastern Mediterranean. J. Fish Biol., 60(3), 764–766.

Louisy, P. (2002): Guide d'identification des poissons marins Europe et Méditerranée. Les Editions Eugen Ulmer, Paris, 430 p.

Lourie, S. A., A. C. J. Vincent & H. J. Hall (1999): Seahorses: An identification guide to the world's species and their conservation. Project Seahorse, London, 214 p.

Nijssen, H. & D. A. G. Buizer (1983): First record of the worm pipefish, *Nerophis lumbriciformis* (Pennant, 1776) in coastal waters of the Netherlands, with notes on other animal species recently recorded from the Oosterschelde. Bull. Zool. Mus. Univ. Amsterdam, 9(22), 209–213.

Pérès, J. M. & J. Picard (1964): Nouveau manuel de bionomie benthique de la Mer Méditerranée. Rec. Trav. Stat. Mar. Endoume, 31(47), 1–137.

Reina-Hervàs, J. A. (1989): Contribución al estudio de la F. Syngnathidae (Pisces) en las costas del sureste de España. Arch. Mus. Bocage, n. s., 1(21), 325–334.

Reina-Hervàs, J. A., R. Muñoz-Chápuli & M. Blasco (1981–1982): Presencia de teleosteos atlánticos en el Mediterráneo occidental. Mon. Trab. Zool. Málaga, 3–4, 49–56.

Riedl, R. (1991): Fauna e flora del Mediterraneo. Franco Muzzio Editore, Padova, 777 p.

Seurat, L. G. (1934): Formations littorales et estuaires de la Syrte Mineure (Golfe de Gabès). Bull. Stat. Océanogr. Salammbô, 32, 1–65.

Tortonese, E. (1970): Fauna d'Italia, Vol. 10. Osteichthyes (Pesci ossei). Parte prima. Edizioni Calderini, Bologna, 565 p.

Vincent, A. C. J., A. Berglund & I. Ahnesjo (1995): Reproductive ecology of five pipefish species in one eelgrass meadow. Environ. Biol. Fish., 44(4), 347–361.

Vinciguerra, D. (1882–1883): Risultati ittiologici della crociere del 'Violante'. Ann. Mus. Civ. Stor. Nat. Genova, pp. 465–590.

Vinciguerra, D. (1884): Materiali per lo studio della fauna tunisina raccolti da G. et L. Doria. 1. Pesci. Ann. Mus. Civ. Stor. Nat. Genova, pp. 393–445.

Wheeler, A. (1969): The fishes of the British Isles and North-West Europe. McMillan, London, 613 p.

Whitfield, A. K. (1995): Threatened fishes of the word: *Hippocampus capensis* Boulender, 1990 (Syngnathidae). Environ. Biol. Fish., 44(4), 362.

Original scientific article
Received: 2008-05-01

UDC 597.311.2(262.4)

TWO RECENT RECORDS OF THE GREAT WHITE SHARKS, *CARCHARODON CARCHARIAS* (LINNAEUS, 1758) (CHONDRICHTHYES: LAMNIDAE), CAUGHT IN TURKISH WATERS

Hakan KABASAKAL
Ichthyological Research Society, Atatürk mahallesi, Menteşoğlu caddesi, İdil apt., No: 30/4, Ümraniye, TR-34764 İstanbul, Turkey
E-mail: hakankabasakal@superposta.com

ABSTRACT

The status of the great white shark, Carcharodon carcharias *(Linnaeus, 1758), in Turkish waters has always been a point of controversy. In 1967 and 1991, two great white sharks were captured in the Sea of Marmara and in the Aegean Sea, respectively, which have never been reported in the literature. The recently developed tuna farm industry along the Turkish coast of the Mediterranean and Aegean Seas can increase the possibility to encounter great white sharks, and this fact necessitates certain monitoring of the interactions between the white sharks and fishing activities.*

Key words: great white shark, *Carcharodon carcharias*, captures, Turkish seas, Mediterranean Sea

DUE CATTURE RECENTI DEL GRANDE SQUALO BIANCO, *CARCHARODON CARCHARIAS* (LINNAEUS, 1758) (CHONDRICHTHYES: LAMNIDAE), IN ACQUE DELLA TURCHIA

SINTESI

Lo stato del Grande squalo bianco, Carcharodon carcharias *(Linnaeus, 1758), in acque delle Turchia, ha sempre suscitato molte controversie. Nel 1967 e nel 1991 due grandi esemplari di questa specie sono stati catturati rispettivamente nel Mar di Marmara e nel Mar Egeo, ma le catture non sono mai state riportate in letteratura. L'avvio recente dell'allevamento industriale di tonno lungo la costa turca nei mari Mediterraneo ed Egeo può incrementare la possibilità di incontrare il Grande squalo bianco, e tale fatto necessita di un monitoraggio delle interazioni fra gli squali bianchi e le attività di pesca.*

Parole chiave: Grande squalo bianco, *Carcharodon carcharias*, catture, acque della Turchia, mare Mediterraneo

INTRODUCTION

The status of the great white shark, *Carcharodon carcharias* (Linnaeus, 1758), in Turkish waters has always been a point of controversy, whether this enormous predatory shark is present along the Anatolian coast. Although the great white shark has been mentioned by some previous researchers *(e.g.*, Devedjian, 1926; Akşıray, 1987; Mater & Meriç, 1996), there are still uncertainties regarding the historical or contemporary records of *C. carcharias* in Turkish seas. Recently, Kabasakal (2003) reported the historical records of 15 great white sharks, caught or sighted by the bluefin tuna handliners in the Sea of Marmara, between 1881 and 1985. Furthermore, 3 great white sharks, caught or sighted along the Turkish coast of the northern Aegean Sea were reported by Kabasakal & Kabasakal (2004).

In the present study, two captures of the great white shark in 1967 and 1991, in the Sea of Marmara and in the Aegean Sea, respectively, are reported, with the status of *C. carcharias* in Turkish seas discussed.

MATERIAL AND METHODS

The present study is a part of the extensive research to figure out the current status of the sharks of Turkish waters, which was initiated in 2000 by Ichthyological Research Society (IRS; KANIT Project –Tür**k** Sul**a**rı**n**da Yaşayan Köpekbal**ı**klarının **T**esbiti Projesi [Identifying the Sharks of Turkish Waters]; KANIT means "proof" in Turkish). Documents regarding the captures of two great white sharks were donated to IRS by Mr. Ateş Evirgen, an underwater photographer, and Mr. M. Necati Karamanoğlu, a diver. During this research, photos documenting two captures of white sharks were found. These images were published in Baldridge (1976) (specimen No. 1) and in a daily newspaper (specimen No. 2). The examined materials are kept in the archives of IRS and available for inspection on request.

RESULTS

Specimen No. 1

The first specimen (Fig. 1) was caught by a tuna handliner off the southern coast of Büyükada (Fig. 3), in 1967. Identification of this specimen as *C. carcharias* is based on the following characters: the triangular teeth, the black mark on the tip of the lower surface of the pectoral fin, and the robust and massive body. Regarding the explanation accompanying the photograph of specimen No. 1, which is written as *"Turkish fishermen struggled for thirteen hours to catch this monster... ...on the shores of the Bosporus"*, the catch site is not correct. This great white shark was hooked off the southern coast of Büyükada – one of the two main fishing areas of *C. carcharias* in the Sea of Marmara, reported by Kabasakal (2003) – and after a long struggle, it was landed on the southeastern coast of Bosporus, near Salacak pier, a fishing village reputed for tuna handliners during the 20th century.

The hook protruding from the lower jaw of the great white shark seen in figure 1 is a typical long-shank shark hook. The length of this type of hooks usually varied between 30 to 40 centimetres; however, during the days of tuna handlining in Bosporic and Marmaric waters, fishermen used to use regular tuna hooks, with the length not exceeding 20 centimetres (Mengi, 1977). For this reason, those fishermen seemed to have gone to sea for the targeted capture of a large shark.

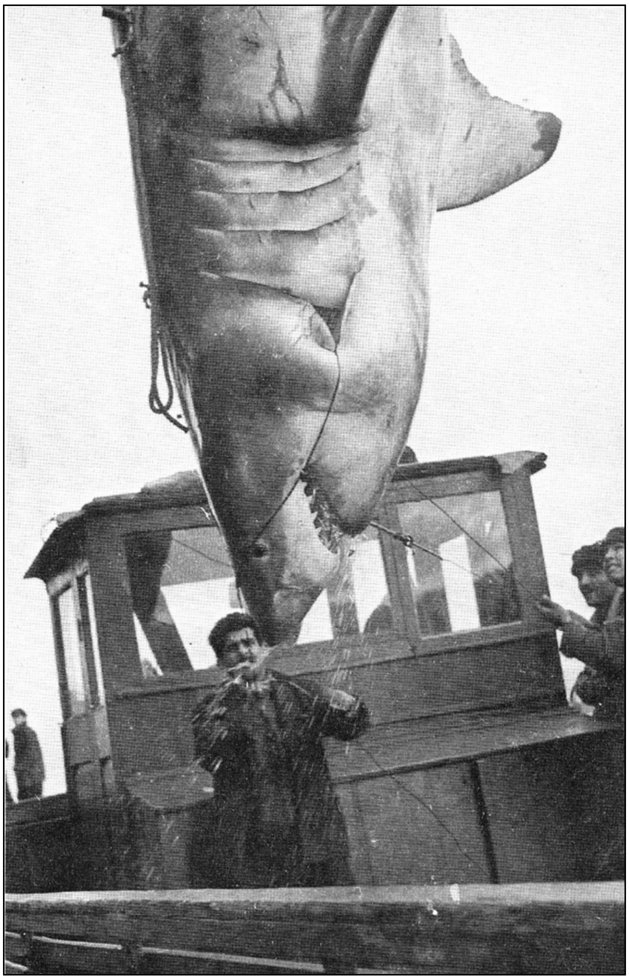


Fig. 1: Great white shark** (Carcharodon carcharias* ***Linnaeus, 1758; specimen No. 1) captured in 1967 off Büyükada. (Photo: IRS Archive)

Sl. 1: Beli morski volk** (Carcharodon carcharias* ***Linnaeus, 1758; primerek št. 1), ujet leta 1967 v bližini Büyükade. (Foto: Arhiv IRS)


yağmurlu olacak.
● 18 MART 1991
PAZARTESİ

Turizmciler çok korktu!

5 metre boyunda 3.5 tonluk köpekbalığının Ege'de yakalanması herkesten çok turizmcilerin canını sıktı

■ Korku filmi Javs'taki kadar büyük bir köpekbalığı önceki gün Foça açıklarında "Necipoğlu-2" isimli balıkçı teknesiyle avlanan balıkçılar tarafından tekneye çekildiğinde herkesin tüyleri diken diken oldu.. Yarılan karnından 1 metre boyunda orkinos çıkartılan dev gibi canavarın İstanbul'a getirilmesi büyük bir sorun oldu..

Acaba nereden geldi?

■ Haberi öğrenen turizmciler olaydan duydukları endişeyi şöyle dile getirdi:" İyi ki yaz sezonu açılmadan yakalandı.. Eğer sahiller insanla doluyken bu canavar gelmiş olsaydı o zaman büyük bir facia olabilirdi. Yine de bilimadamlarının bu kadar büyük bir balığın nereden gelmiş olabileceğini araştırması gerekir" (Nuray KALCI)

Jaws Ege'de- 1.5 tonluk vinç kamyondan indirilirken balığı taşıyamadı. Bunun üzerine kamyon üzerindeyken karnı yarıldı ve yediği dev orkinos çıkartıldıktan sonra kamyondan aşağı indirilebildi.

Fig. 2: Page of the newspaper reporting the capture of a great white shark (specimen No. 2) on March 18, 1991, off Foça. (Photo: IRS Archive)
Sl. 2: Časopisna stran s poročilom o belem morskem volku (primerek št. 2), ujetem 18. marca 1991 v bližini Foçe. (Foto: Arhiv IRS)

Specimen No. 2

The second specimen (Fig. 2) was caught by a commercial purse-seiner, "Necipoğlu 2", off the coast of Foça (Fig. 3) on 18 March 1991. Identification of this specimen as *C. carcharias* is based on the following characters: a triangular upper tooth, the shape of snout and mouth, and the size of the gill slits. According to the report seen in the newspaper, the shark's total length was estimated at ca. 5 m and its weight at 3,500 kg; however, the weight of the shark seems to be overestimated. The fishermen tried to lift the shark by means of a crane of 1,500 kg maximum capacity, but during the first trial the lifting wire broke off. Thus, the weight of the specimen No. 2 should be at least 1,500 kg, which seems more accurate than the reported weight. After the capture, the great white shark was transported to İstanbul Fish Market for auction. Here, the shark was eviscerated; a tuna fish, ca. 1 m long, was found in the stomach contents.

DISCUSSION

The historical and contemporary occurrences of *C. carcharias* in the Mediterranean basin have been subjected to several investigations (Barrull, 1993–94; Fergusson, 1996; De Maddalena, 2000; Barrull & Mate, 2001; Celona, 2002; De Maddalena, 2002; Kabasakal, 2003; Morey *et al.*, 2003). According to Fergusson (1996), Mediterranean distribution of the great white shark is concentrated mainly in the western and central parts of the basin. Comparing the numbers of the great white sharks recorded from the Catalonian Sea (26; Barrull & Mate, 2001), Balearic Islands (27; Morey *et al.*, 2003), northern and central Adriatic Sea (83; De Maddalena, 2000) and the entire western Mediterranean basin and the Adriatic Sea (85; Fergusson, 1996), only 29 great white sharks have been recorded from the eastern Mediterranean, and the adjacent Aegean and Marmara Seas (Ben-Tuvia, 1971; Fergusson, 1996; Kabasakal, 2003; Kabasakal & Kabasakal, 2004). Three of the specimens reported in Fergusson (1996) are also mentioned by Kabasakal (2003), as Bosporic occurrences of *C. carcharias*. Fergusson (1996) also reported that great white sharks are rare in the Aegean Sea, as well as in the Dardanelles and Bosporus Straits and in the Sea of Marmara – the so-called Turkish Straits System (TSS).

Historically, great white sharks appear to have been encountered in the TSS irregularly since the early 20th century (Devedjian, 1926). Devedjian (1926) reported on a great white shark (TOT 400 cm) captured in the Sea of Marmara, and added that its stomach content included a number of bonitos. Due to the occurrence of great white shark in the prebosporic waters of the Black Sea, Slastenenko (1955–56) included *C. carcharias* in the pontic ichthyofauna; however, since the last 50

years, no specimen of *C. carcharias* has been recorded from the area. Although the presence of *C. carcharias* in the Sea of Marmara has been reported by Bilecenoğlu *et al.* (2002) in the *Checklist of the marine fishes of Turkey*, the information given herewith is probably based on previous recordings. Considering that the last sighting of great white shark in Marmaric waters is dated to May 1985 (Kabasakal, 2003), the current presence of *C. carcharias* in the Sea of Marmara is "questionable" and requires confirmation.

Although the Foça specimen of *C. carcharias* (specimen No. 2) was caught on 18 March 1991, the most recent occurrence of an app. 5 m long shark sighted by a diver along the Anatolian coast of the Aegean Sea was dated to May 1999 (Kabasakal & Kabasakal, 2004). With the addition of two specimens recorded in the present study, the total number of great white sharks reported from the eastern Mediterranean and adjacent seas increased to 31, which constitutes 25.2 and 6.5 percent of the total numbers recorded by Fergusson (1996) and De Maddalena (2006) from the entire Mediterranean Sea, respectively. The role played by sea surface temperatures (SSTs) in affecting the distribution of the great white shark is demonstrated in the literature (Fergusson, 1996; Barrull & Mate, 2001; Kabasakal, 2003; Morey *et al.*, 2003). *C. carcharias*, in the Mediterranean Sea, tolerated SSTs ranging from 7.5°C to 25°C, but few records were

Fig. 3: Fishing localities (circles) of great white sharks in the Sea of Marmara (specimen No. 1) and in the Aegean Sea (specimen No. 2).
Sl. 3: Lokaliteti (krogca) belih morskih volkov v Marmarskem (primerek št. 1) in Egejskem morju (primerek št. 2).

reported in waters with a temperature above 23°C (Fergusson, 1996). Kabasakal (2003) reports that accidental captures of *C. carcharias* in the Sea of Marmara reached their peak from November to April, when SSTs ranged from 7°C (November) to 21°C (April). Three great white sharks, reported in Kabasakal & Kabasakal (2004) from the northeastern Aegean Sea, were captured or sighted between March and May, when SSTs ranged from 13 to 18°C (Kocataş & Bilecik, 1992). The exact date of capture of specimen No. 1 is not known, thus I cannot comment on SST during the time of its catch in Marmaric waters. On the other hand, specimen No. 2 was captured on 18 March 1991, when SST in the central Aegean Sea varied between 13 and 14°C (Kocataş & Bilecik, 1992). Fergusson (1996) reports on the capture of three great white sharks along the Greek coast of the Aegean Sea, in July 1951 (SST 20–21.5°C), September 1972 (SST 22–23°C) and December 1984 (SST 13–17°C). Regarding the data presented by Fergusson (1996), Kabasakal (2003) and Kabasakal & Kabasakal (2004), and the results of the present study, eurythermal nature of the great white shark suggests that the species can remain in Aegean and Marmaric waters all the year round.

According to Barrull & Mate (2001), encounters of the great white shark are most common at insular sites and in association with pelagic fisheries for large teleosts such as tuna or swordfish. Although some seasonal differences in the spatio-temporal occurrence of *C. carcharias* can be observed, the species seem to be present around the western Mediterranean islands all the year round (Morey *et al.*, 2003).

Specimen No. 1 was captured off Büyükada Island, where two other great white sharks were caught in 1920 and 1926 (case Nos. 4 & 6 in Kabasakal, 2003). Specimen No. 2 was captured approximately a mile off Uzunada Island near Foça. Kabasakal & Kabasakal (2004) report the capture of a great white shark off the western coast of Bozcaada island in 1996, and the sighting of another specimen by a gill-netter in the same waters. Based on Kabasakal (2003), Kabasakal & Kabasakal (2004) and the present results, *C. carcharias* can be regarded primarily a coastal shark occurring in waters of the continental shelf, where it is captured or sighted in the Seas of Turkey.

Tuna has always been a primary prey for Mediterranean white sharks, and interactions between these apex predators and tuna fishery have been documented in details (Barrull & Mate, 2001; De Maddalena, 2002; Kabasakal, 2003; Morey *et al.*, 2003; Galaz & De Maddalena, 2004). Great white shark has been a by-catch of Marmaric tuna hand-liners, until the decline of tuna stock in the Sea of Marmara in 1980's (Kabasakal, 2003). The recent presence of *C. carcharias* in coastal waters of the Turkish Aegean Sea in the1990's, can also be inferred from accidental captures by commercial fishing gears deployed for tuna (*e.g.* purse-seines), as

well as other bony fishes (*e.g.* gill-nets). One of the white sharks reported by Kabasakal (2004) (specimen caught on March 1996) and specimen of the present study were both captured by commercial purse-seiners, which deployed their nets to entrap tuna schools.

The apparent seasonal distribution of white sharks along Turkish coasts can be related to trophic migrations of prey species, such as tunas and cetaceans. The stomach content of specimen No. 2 contained a ca. 1 m long tuna, as well. Although the tuna stock in Marmaric waters has been declined or even completely depleted (Karakulak & Oray, 1994), the Sea of Marmara is inhabited by a remarkable population of dolphins. In the Mediterranean Sea, large white sharks also feed on cetaceans (Fergusson, 1996; Barrull & Mate, 2001; De Maddalena, 2002; Morey *et al.*, 2003; Celona *et al.*, 2006). Lipej *et al.* (2004) report that in the Adriatic Sea white sharks feed primarily on dolphins, tunas and carrion. Some white sharks, which in pursuit of dolphin schools seasonally migrate between the Aegean and Marmara Seas, can also enter the Marmaric waters.

The recently developed tuna farm industry along the Turkish coast of the Mediterranean and Aegean Seas can increase the possibility of encountering great white sharks. According to the crew of a towing boat belonging to a Turkish tuna farm, at least one non-fatal shark attack by an unidentified species was experienced by a diver, checking and/or repairing the net (A. Evirgen, *pers. comm.*). The attack took place off northern Cyprus, while the towing boat was on the way to Çeşme (Turkish coast of the central Aegean Sea). There have been several unverified reports of sharks being captured in tuna tow cages and in inshore tuna farm cages (Galaz & De Maddalena, 2004). Whether the shark trapped in a tuna cage is a white shark or not, attempt to remove a large predator from a tuna cage is a difficult and dangerous task. Due to notable risk to the people on board, fishermen usually decide to kill the shark.

The white shark is a protected species. Due to the vulnerable status of white sharks in the Mediterranean Sea, it is included in Appendix 2 of Bern Convention; Appendix 2 of Barcelona Convention. It is also considered vulnerable by IUCN and FAO, and proposed for CITES listing on Appendix I and II (Serena, 2005). Contrary to international efforts for protecting *C. carcharias*, there have been no attempts to set regulations for the conservation of the species in Turkish waters. In ecological terms, white shark is a '*k-selected*' species – slow growth, late maturation and low fecundity, which means that once the population of the white shark is overfished, it would take many years to recover. Taking into consideration all these facts, an extensive research should be carried out to figure out the current status of the great white shark in Turkish waters, as well as monitoring of the interactions between the species and fishing activities.

ACKNOWLEDGMENTS

I would like to thank Mr. Ateş Evirgen (İstanbul) and Mr. M. Necati Karamanoğlu (İstanbul) for providing me with data on the capture of white sharks.

DVA NOVEJŠA PODATKA O BELEM MORSKEM VOLKU *CARCHARODON CARCHARIAS* (LINNAEUS, 1758) (CHONDRICHTHYES: LAMNIDAE), UJETEM V TURŠKIH VODAH

Hakan KABASAKAL
Ichthyological Research Society, Atatürk mahallesi, Menteşoğlu caddesi, İdil apt., No: 30/4, Ümraniye, TR-34764 İstanbul, Turkey
E-mail: hakankabasakal@superposta.com

POVZETEK

Status belega morskega volka Carcharodon carcharias *(Linnaeus, 1758) v turških teritorialnih vodah je že od nekdaj sporen. Leta 1967 in 1991 sta bila v Marmarskem oz. Egejskem morju ujeta dva osebka te vrste, o katerih pa v literaturi doslej še ni bilo zaslediti nobenih podatkov. Nedavno odprte farme za industrijsko gojenje tunov vzdolž turškega obrežja v Sredozemskem in Egejskem morju utegnejo povečati možnost pojavljanja belih morskih volkov, in prav zaradi tega dejstva bi bil po avtorjevem mnenju potreben temeljit monitoring interakcij med belimi morskimi volkovi in ribiškimi dejavnostmi.*

Ključne besede: beli morski volk, *Carcharodon carcharias*, ujeta primerka, turške vode, Sredozemsko morje

REFERENCES

Akşıray, F. (1987): Türkiye Deniz Balıkları Ve Tayin Anahtarı. 2nd ed. Publication no. 3490, Istanbul University, Istanbul, 811p.

Baldridge, H. D. (1976): Shark Attack. Everest Books, London, 278 p.

Barrull, J. (1993–94): Cita histórica de tiburón blanco *Carcharodon carcharias* (Linnaeus, 1758), en el Mar Catalán (Mar Mediterráneo), documentada con dientes de la mandíbula. Misc. Zool., 17, 283–285.

Barrull, J. & I. Mate (2001): Presence of the great white shark, *Carcharodon carcharias* (Linnaeus, 1758) in the Catalonian Sea (NW Mediterranean): review and discussion of records, and notes about its ecology. Annales, Ser. Hist. Nat., 11(1), 3–12.

Ben-Tuvia, A. (1971): Revised list of the Mediterranean fishes of Israel. Isr. J. Zool., 20, 1–39.

Bilecenoğlu, M., E. Taşkavak, S. Mater & M. Kaya (2002): Checklist of the marine fishes of Turkey. Zootaxa, 113, 1–194.

Celona, A. (2002): Due catture di squalo bianco, *Carcharodon carcharias* (Linneo, 1758) avvenute nelle acque di Marzamemi (Sicilia) negli anni 1937 e 1964. Annales, Ser. Hist. Nat., 12(1), 207–210.

Celona, A., De Maddalena, A. & G. Comparetto (2006): Evidence of a predatory attack on a bottlenose dolphin *Tursiops truncatus* by a great white shark *Carcharodon carcharias* in the Mediterranean Sea. Annales, Ser. Hist. Nat., 16(2), 159–164.

De Maddalena, A. (2000): Historical and contemporary presence of the great white shark, *Carcharodon carcharias* (Linnaeus, 1758), in the northern and central Adriatic Sea. Annales, Ser. Hist. Nat., 10(1), 3–18.

De Maddalena, A. (2002): Lo squalo bianco nei mari d'Italia. Ireco, Formello, 144 p.

De Maddalena, A. (2006): The great white shark, *Carcharodon carcharias* (Linnaeus, 1758) of the Settala Museum in Milan. Boll. Mus. Civ. Stor. Nat. Venezia, 57, 149–154.

Devedjian, K. (1926): Pêche et Pécheries en Turquie. Imprimerie de l'Administration de la Dette Publique Ottomane, İstanbul. (Türkiye'de Balık Ve Balıkçılık, Turkish edition published in 2006, Aras, İstanbul).

Fergusson, I. K. (1996): Distribution and autecology of the white shark in the eastern north Atlantic Ocean and the Mediterranean Sea. In: Klimley, A. P. & D. G. Ainley (eds.): Great white sharks. The biology of *Carcharodon carcharias*. Academic Press, San Diego, pp. 321–345.

Galaz, T. & A. De Maddalena (2004): On a great white shark, *Carcharodon carcharias* (Linnaeus, 1758), trapped in a tuna cage off Libya, Mediterranean Sea. Annales, Ser. Hist. Nat., 14(2), 159–164.

Kabasakal, H. (2003): Historical records of the great white shark, *Carcharodon carcharias* (Linnaeus, 1758) (Lamniformes: Lamnidae), from the Sea of Marmara. Annales, Ser. Hist. Nat., 13(2), 173–180.

Kabasakal, H. & E. Kabasakal (2004): Sharks captured by commercial fishing vessels off the coast of Turkey in the northern Aegean Sea. Annales, Ser. Hist. Nat., 14(2), 171–180.

Karakulak, F. S. & I. K. Oray (1994): The length-weight relationship of the bluefin tunas *(Thunnus thynnus* L., 1758) caught in Turkish waters. J. Aquat. Prod., 8(1–2), 159–171.

Kocataş, A. & N. Bilecik (1992): Ege Denizi ve Canlı Kaynakları (Aegean Sea and its Living Resources). Seri A, No. 7. Su Ürünleri Araştırma Enstitüsü Müdürlüğü, Bodrum.

Lipej, L., A. De Maddalena & A. Soldo (2004): Sharks of the Adriatic Sea. Knjižnica Annales Majora, Koper, 256 p.

Mater, S. & N. Meriç (1996): Deniz Balıkları – Pisces. In: Kence, A. & C. C. Bilgin (eds.): Türkiye Omurgalılar Tür Listesi. TÜBİTAK, Ankara, pp. 129–172.

Mengi, T. (1977): Balıkçılık Tekniği. MET/ER Matbaası, İstanbul.

Morey, G., M. Martínez, E. Massutí & J. Moranta (2003): The occurrence of white sharks, *Carcharodon carcharias*, around the Balearic Islands (western Mediterranean Sea. Environ. Biol. Fish., 68, 425–432.

Slastenenko, E. (1955–56): The Fishes of the Black Sea Basin. Et ve Balık Kurumu Umum Müdürlüğü Yayınlarından, İstanbul.

Serena, F. (2005): Field identification guide to the sharks and rays of the Mediterranean and Black Sea. FAO Species Identification Guide for Fishery Purposes. FAO, Rome, 97 p.

Original scientific article
Received: 2008-04-17

UDC 597.5(262.16)

MORPHOLOGICAL CHARACTERS AND MERISTIC COUNTS IN TWO ANGLERFISHES, *LOPHIUS BUDEGASSA* AND *L. PISCATORIUS* (OSTEICHTHYES: LOPHIIDAE) FROM TUNISIAN COASTAL WATERS (CENTRAL MEDITERRANEAN)

Nawaim NEGZAOUI-GARALI & Mohamed BEN SALEM
Unité de Recherches Zoologie et Ecologie des Milieux aquatiques, Faculté des Sciences de Tunis,
Campus universitaire 2090 El Manar II, Tunis, Tunisie
E-mail: nawaim_negzaoui@yahoo.fr

Christian CAPAPÉ
Laboratoire d'Ichtyologie, case 104, Université Montpellier II, Sciences et Techniques du Languedoc, 34095 Montpellier cedex 05, France

ABSTRACT

The paper examines and presents morphological characters and meristic counts carried out in anglerfishes Lophius budegassa *Spinola, 1807 and* L. piscatorius *Linnaeus, 1758 collected off the Tunisian coast. Mean-comparisons of morphometric indexes and meristic counts show an interspecific variation between the two species and sexual dimorphism in both species. Both positive and regular increase of illicium length for both species could be considered as an improvement of this fishing device with special regard to age.*

Key words: *Lophius budegassa*, *Lophius piscatorius*, morphometric indexes, meristic counts, Tunisia, central Mediterranean

CARATTERI MORFOLOGICI E CONTEGGI MERISTICI IN DUE SPECIE DI RANA PESCATRICE, *LOPHIUS BUDEGASSA* E *L. PISCATORIUS* (OSTEICHTHYES: LOPHIIDAE), DI ACQUE COSTIERE TUNISINE (MEDITERRANEO CENTRALE)

SINTESI

L'articolo esamina e presenta i caratteri morfologici e i conteggi meristici di due specie di rana pescatrice Lophius budegassa *Spinola, 1807 e* L. piscatorius *Linnaeus, 1758, pescate al largo della costa tunisina. I confronti degli indici morfometrici e dei conteggi meristici indicano variazioni interspecifiche e dimorfismo sessuale in entrambe le specie. La crescita positiva e regolare della lunghezza dell'illicio in entrambe le specie può venire considerata come un miglioramento dell'attrezzatura di pesca, tenendo in considerazione anche l'età dell'animale.*

Parole chiave: *Lophius budegassa*, *Lophius piscatorius*, indici morfometrici, conteggi meristici, Tunisia, Mediterraneo centrale

INTRODUCTION

Two anglerfishes are known to occur off the Tunisian coast such as off other northern African areas (Dieuzeide *et al.*, 1954; Collignon & Aloncle, 1972; Caruso, 1986), the black anglerfish, *Lophius budegassa* Spinola, 1807, and the white anglerfish, *Lophius piscatorius* Linnaeus, 1758. Although the occurrence of both species have been locally reported from northern Tunisian area and southward, in the Gulf of Gabès (Bradaï *et al.*, 2004), they have not been studied thoroughly as yet, probably because they had previously been considered by-catch species by the local fishermen. During the last decade, production of both species considerably increased, with *L. budegassa* and *L. piscatorius* targeted for local consumption, although assigned mainly for exportation. Specimens collected throughout Tunisian coastal waters have given us an opportunity to report on distributional aspects and some morphometric and meristic characters on both species collected in the area in order to clarify the distinctions between *L. piscatorius* and *L. budegassa*, considering that both species are generally confused under the same vernacular name throughout the Mediterranean Sea.

MATERIAL AND METHODS

Statistical data on both species production in Tunisian waters were provided by a public fishery institution known as 'Direction Générale des Pêches et de l'Aquaculture'. Investigations were conducted at the fishing sites off the Tunisian coast between November

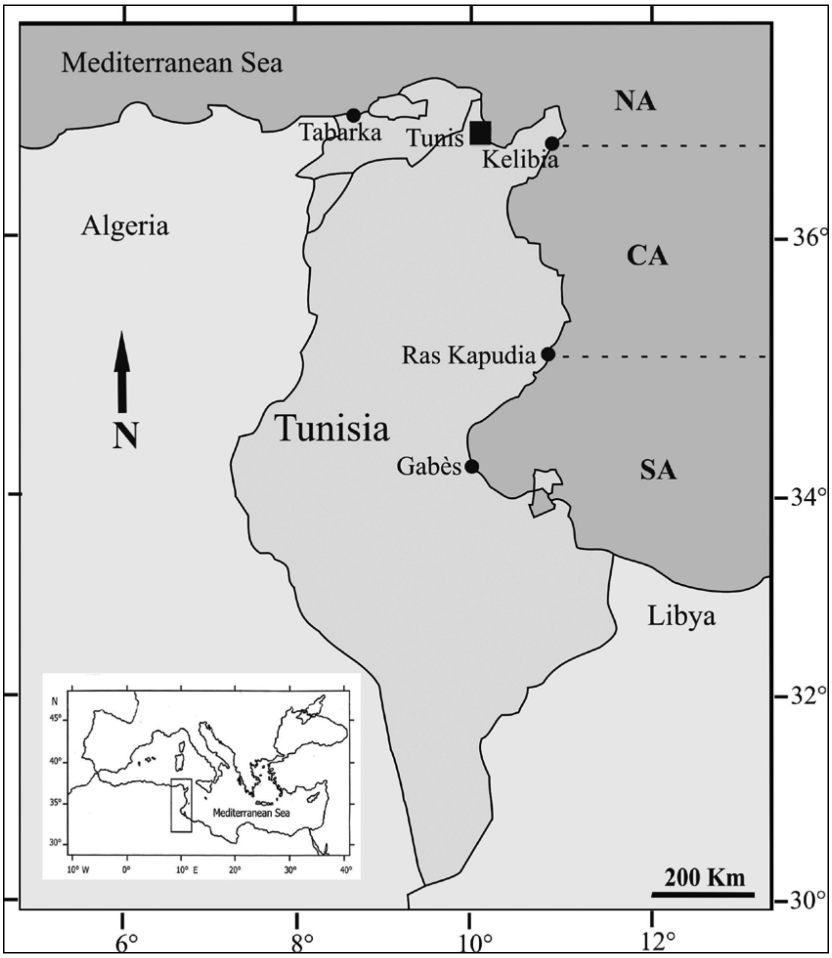


Fig. 1: Map of the Mediterranean Sea showing Tunisia, and map of the Tunisian coast showing the landing sites of both** L. budegassa **and** L. piscatorius **in three fishing areas: northern area (NA) from Tabarka to Kelibia, central area (CA) south of Kelibia to Ras Kapudia, and southern area (SA) south of Ras Kapudia to the Libyan border.

Sl. 1: Zemljevid Sredozemskega morja z označeno Tunizijo in zemljevid tunizijskih obrežnih voda z lokacijami v treh območjih, kjer so bili ujeti primerki male morske spake** L. budegassa **in morske spake** L. piscatorius**: severno območje (NA) od Tabarke do Kelibie, osrednje območje (CA) južno od Kelibie do Ras Kapudie, in južno območje (SA) južno od Ras Kapudie do libijske meje.

2004 and December 2005. Eighteen morphometric characters were measured to the nearest millimetre as follows (see figure 3): total length (TL), standard length (SL), head length (HL), eye diameter (ED), pre-orbitary length (PrOL), post-orbitary length (PsOL), inter-orbitary length (IOL), maxillary length (ML), pre-pectoral length (PPectL), pre-first dorsal fin length (PD1), pre-second dorsal fin length (PD2), pre pelvic length (PPelL), pre-anal length (PaL), pectoral length (PecL), pectoral height (PecH), body depth (BD), illicium (IL), esca length (EsL).

From these measurements, we have calculated the following morphometric indexes: SL/TL, BD/SL, HL/SL, PPectL/SL, PD1/SL, PD2/SL, PPelL/SL, PaL/SL, PecL/SL, PecH/SL, IL/SL, ED/HL, PrOL/HL, PsOL/HL, IOL/HL, ML/HL, IL/HL and EsL/IL.

Some meristic counts were used, such as: number of rays in first and second dorsal fins, pectoral fin, pelvic fin, anal fin, caudal fin, and number of vertebrae.

Two specimens, one female *Lophius budegassa* and one female *Lophius piscatorius*, are preserved in the ichthyological collection of the Faculté des Sciences de Tunis, with catalogue number FST-LOPH-piscatorius-01 and FST-LOPH-budegassa-01, respectively.

Test for significance ($p < 0.05$) were performed using Student's t test, Snedecor's F test, and chi-square test ($\chi 2$). Linear regression was performed following log transformation of the data. Correlations were assessed by least-squares regression.

RESULTS

Production and sample description

Landings for both craft fishing and trawl fleets were monthly registered between 1997 and 2003 for every landing site (Fig. 1), mainly concerning the northern area, from Tabarka to Kelibia, and the central area, south of Kelibia to Ras Kapudia. Unfortunately, the southern area production, from Ras Kapudia to the Libyan border, was not included in the statistical data (see Table 1), although both species were landed in the area according to Ben Othman (1971, 1973) and Ktari-Chakroun & Azouz (1971). Consequently, the local production was probably underestimated. During a period of seven years, the anglerfish production ranged approximately between 30 and 47 tons per year off the Tunisian coast (Tab. 2). Specimens were mainly collected by trawl due to their benthic life. Moreover, it appears that landings were significant mainly in June and in November (Fig. 2). Of the 543 specimens examined, 416 were *Lophius budegassa* (135 males, 280 females, and one hermaphrodite), and 127 *Lophius piscatorius* (34 males, 76 females, 17 undetermined). The monthly collection of *L. budegassa* and *L. piscatorius* collected off the Tunisian coast are given in Table 3. In our sample, females significantly outnumbered males in *L. budegassa* ($\chi 2 = 50.56$; df = 1) and *L. piscatorius* ($\chi 2 = 16.03$; df = 1).

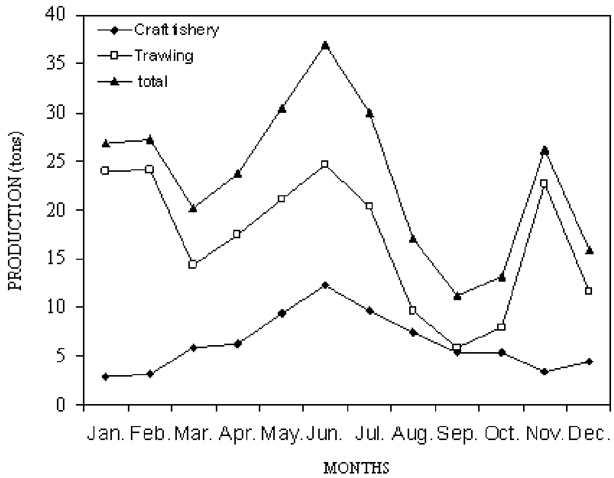


Fig. 2: Monthly production (in tons) of anglerfishes from Tunisian coastal waters between 1997 and 2004.
Sl. 2: Mesečni ulov (v tonah) morskih spak v tunizijskih obrežnih vodah med letoma 1997 in 2004.

Tab. 1: Production of anglerfishes (in tons) by fishing year for the three Tunisian areas between 1997 and 2004.
Tab. 1: Ulov morskih spak (v tonah) po posameznih ribolovnih letih v treh tunizijskih območjih med letoma 1997 in 2004.

Areas	**Craft fishery**		**Trawling fishery**		**Total**	
	Landings (t)	%	Landings (t)	%	Landings (t)	%
Northern area	70.84	94.1	195.94	96.2	266.78	95.6
Central area	4.46	5.9	7.78	3.8	12.24	4.4
Southern area			0.03	0	0.02	0
Total	75.30	100.0	203.75	100.0	279.04	100.0
	27.0%		73.0%		100%	

Tab. 2: Total production of anglerfishes (in tons) per year and by fishing year method.
Tab. 2: Skupni ulov morskih spak (v tonah) na leto in po metodi ribolovnega leta.

Years	Craft fishery landings (t)	Trawl landings (t)	Total
1997	13.25	20.22	33.47
1998	5.92	23.89	29.81
1999	5.80	32.45	38.25
2000	7.92	38.81	46.73
2001	11.52	23.98	35.50
2002	14.52	28.09	42.61
2003	10.86	30.65	41.51

General morphology

Body dorso-ventrally flattened, head strongly depressed about as wide as long (Figs. 4, 5). Gills openings extending below and behind pectoral fin. Medially, there are three modified dorsal fin rays, the anterior one called the 'lure' or illicium, ending with a fleshy appendage or esca, simple-pennant-like flap in *L. budegassa*, composed of two broad, flattened, leaf-like blades in *L. piscatorius* (Fig. 6). Third dorsal cephalic dorsal spine short in *L. budegassa*. Dorsal spines II–VI long and stout and bearing numerous well-developed, twisted tendrils in *L. piscatorius. L. piscatorius* body brownish to greyish slightly marbled, pectoral black edged with dark notches, peritoneum light while in *L. budegassa* body uniformly brownish or greyish, with dark striped tail, peritoneum dark (Fig. 5).

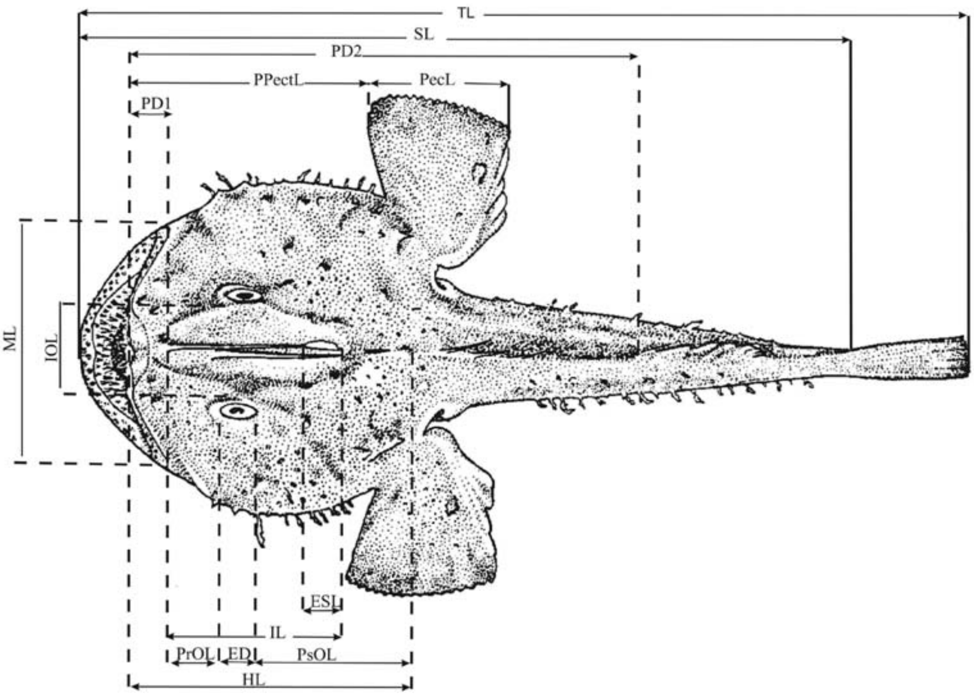


Fig. 3: Morphometric characters measured on dorsal surface in both** L. budegassa **and** L. piscatorius: **total length (TL), standard length (SL), head length (HL), eye diameter (ED), pre-orbitary length (PrOL), post-orbitary length (PsOL), inter-orbitary length (IOL), maxillary length (ML), pre-pectoral length (PPectL), pre-first dorsal fin length (PD1), pre-second dorsal fin length (PD2), pectoral length (PecL), illicium (IL), esca length (EsL).
Sl. 3: Morfometrični znaki, izmerjeni na hrbtni površini morskih spak** L. budegassa **in** L. piscatorius: **celotna dolžina (TL), standardna dolžina (SL), dolžina glave (HL), premer očesa (ED), preorbitalna dolžina (PrOL), postorbitalna dolžina (PsOL), interorbitalna dolžina (IOL), dolžina čeljusti (ML), predpektoralna dolžina (PPectL), dolžina od gobca do prve hrbtne plavuti (PD1), dolžina od gobca do druge hrbtne plavuti (PD2), dolžina prsne plavuti (PecL), dolžina kožnega izrastka (IL), dolžina vabe (EsL).

Morphometric characters

The smallest *L. budegassa* was 154 mm total length and weighing 37 g, the largest 700 mm and weighing 4,048 g. The smallest *L. piscatorius* was 190 mm total length and weighing 67 g, the largest 1,090 mm and weighed 16,000 g. There is a positive relationship between total length and total mass for both species, in *L. budegassa*: Log TM = 3.03 Log TL – 4.46; r = 0.97; n = 416, while *in L. piscatorius*: Log TM = 3.05 Log TL – 4.15; r = 0.97; n = 127.

Lengths of illicium and esca for both species were compared in Table 4. There were positive relationships between illicium length and standard length, between illicium length and head length, between esca length and illicium length for both species (Tab. 5).

Mean comparisons of morphometric indexes between male and female *Lophius budegassa* are given in Table 6, and between male and female *L. piscatorius* in Table 7. Some indexes, such as BD/SL, PD2/SL, PD2/SL, PaL/SL, PecH/SL, IL/SL, ED/HL, IOL/HL, IL/HL and EsL/IL, were significantly different in the first species; PD2/TL and PecH/SL in the second one. Mean comparisons of morphometric indexes between *L. budegassa* and *L. piscatorius* are given in Table 8: SL/TL, BD/SL, HL/SL, PPectL/SL, PD1/SL, PD2/SL, PPelL/SL, IL/SL, ML/HL, IL/HL and EsL/IL were significantly different between the two species.

Tab. 3: Monthly collection of the examined** L. budegassa **and** L. piscatorius **from Tunisian coastal waters.
Tab. 3: Mesečni ulovi preučenih vrst** L. budegassa **in** L. piscatorius **v tunizijskih obrežnih vodah.

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Lophius budegassa													
Northern area	11	4	10	10	–	–	16	8	23	8	23	28	141
Central area	30	8	8	–	–	41	21	–	–	–	–	6	114
Southern area	–	10	4	19	45	7	38	24	–	7	7	–	161
Total	41	22	22	29	45	48	75	32	23	15	30	34	416
Lophius piscatorius													
Northern area	–	2	–	–	–	–	2	–	13	5	2	14	38
Central area	5	2	3	2	1	21	–	1	–	–	–	2	37
Southern area	–	–	6	–	22	3	4	3	–	2	12	–	52
Total	5	4	9	2	23	24	6	4	13	7	14	16	127

***Tab. 4: Comparison of length of illicium and esca for** L. budegassa **and** L. piscatorius.*
***Tab. 4: Primerjava dolžine kožnega izrastka in vabe pri vrstah** L. budegassa **in** L. piscatorius.*

		Illicia	Esca	Specimen	
Species	**n**	TL range (mm)	TL range (mm)	TL range (mm)	mass range (g)
L. budegassa	416	29–240	2–80	154–700	37–4048
L. piscatorius	127	22–397	10–98	190–1090	67–16000

Tab. 5: Relationships between illicium length and standard length, between illicium length and head length, between esca length and illicium length for both species.
Tab. 5: Razmerja med dolžino kožnega izrastka in standardno dolžino, med dolžino kožnega izrastka in dolžino glave ter med dolžino vabe in dolžino kožnega izrastka pri obeh vrstah.

Species	Equations	n	r	Student's *t* test
L. budegassa	Log IL =1.249 Log SL –2.167	398	0.90	8.61 (+)
	Log IL =1.308 Log HL –1.075	398	0.90	9.62 (+)
	Log EsL =1.235 Log IL –2.192	396	0.90	5.16 (+)
L. piscatorius	Log IL =1.477 Log SL –2.824	124	0.88	7.21 (+)
	Log IL =1.462 Log HL –1.361	124	0.87	6.43 (+)
	Log EsL =1.123 Log IL –1.472	123	0.83	1.97 (+)

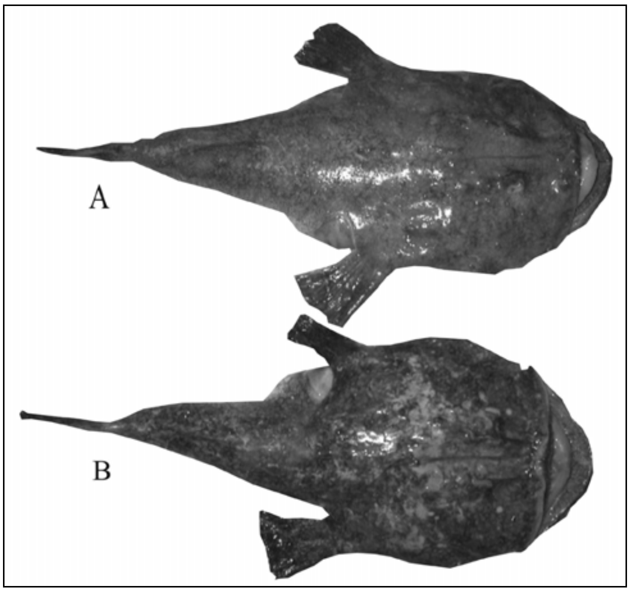


Fig. 4: Dorsal surface. A. *L. budegassa* ***(FST-LOPH-budegassa-01), B.*** *L. piscatorius* ***(FST-LOPH-piscatorius-01).***
Sl. 4: Hrbtna površina. A. *L. budegassa* ***(FST-LOPH-budegassa-01), B.*** *L. piscatorius* ***(FST-LOPH-piscatorius-01).***

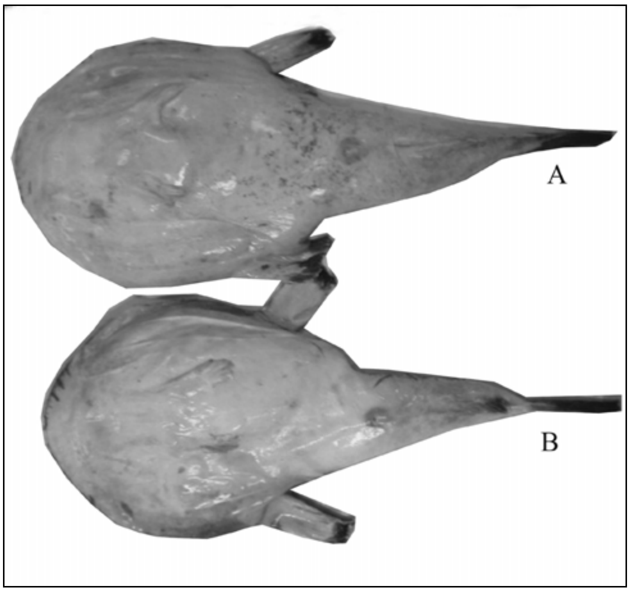


Fig. 5: Ventral surface. A. *L. budegassa* ***(FST-LOPH-budegassa-01), B.*** *L. piscatorius* ***(FST-LOPH-piscatorius-01).***
Sl. 5: Trebušna površina. A. *L. budegassa* ***(FST-LOPH-budegassa-01), B.*** *L. piscatorius* ***(FST-LOPH-piscatorius-01).***

Of the seven meristic counts used to distinguish *L. budegassa* from *L. piscatorius*, three did not show significant differences for both species. In contrast, four other counts such as number of rays in second dorsal fin, pectoral fin, anal fin and number of vertebrae were significantly higher in *L. piscatorius* than in *L. budegassa* (Tab. 9). Moreover, the same meristic counts were significantly higher in female than in male *L. budegassa* (Tab. 10); only three meristic counts were significantly higher in female than in male *L. piscatorius*, number of rays in second dorsal fin, pectoral fin and anal fin (Tab. 10).

Tab. 6: Mean comparison of morphometric indexes between male and female *L. budegassa.*
Tab. 6: Srednja primerjava morfometričnih indeksov med samci in samicami vrste *L. budegassa.*

Index	Males				Females				Student's *t* test	Snedecor's *F* test
	n	range	mean	SD	n	range	mean	SD		
SL/TL	135	71.9–90.1	81.80	1.70	280	59.7–102.2	81.90	2.30	0.40 (–)	1.83 (+)
BD/SL	135	3.4–9.4	6.10	0.91	280	3.2–9.5	6.40	0.99	3.06 (+)	1.18 (+)
HL/SL	135	25.3–45.2	37.40	2.20	280	27.3–54.3	37.20	2.40	0.84 (–)	1.19 (+)
PPectL/SL	135	38.6–104.1	44.80	6.00	280	37.7–90.9	44.90	4.30	0.14 (–)	1.95 (+)
PD1/SL	135	59.0–13.9	10.40	1.50	280	5.9–64.1	11.30	3.50	3.66 (+)	5.44 (+)
PD2/SL	135	58.6–79.1	64.00	2.60	280	12.0–92.8	65.60	4.60	4.51 (+)	3.13 (+)
PPelL/SL	135	16.6–33.1	23.00	2.30	280	15.9–48.7	23.40	2.90	1.52 (–)	1.59 (+)
PaL/SL	135	61.7–72.3	67.40	2.20	280	56.5–97.2	69.10	3.00	6.52 (+)	1.86 (+)
PecL/SL	135	14.8–29.4	22.30	3.17	280	14.6–36.5	22.60	3.12	0.91 (–)	1.03 (+)
PecH/SL	135	15.0–27.5	18.50	1.66	280	13.9–28.1	18.10	1.69	2.29 (+)	1.04 (+)
IL/SL	129	11.8–37.4	25.50	3.90	268	1.8–4.3	27.40	5.00	4.13 (+)	1.64 (+)
ED/HL	135	10.0–24	14.00	2.00	280	5.5–25.5	12.40	2.50	7.02 (+)	1.56 (+)
PrOL/HL	135	40.4–84.4	50.40	5.30	280	11.8–89.3	51.30	5.60	1.59 (–)	1.12 (+)
PsOL/HL	135	25.9–52.9	34.60	4.20	280	22.6–57.2	33.90	4.50	1.55 (–)	1.15 (+)
IOL/HL	135	11.6–42.5	23.90	5.40	280	12.6–57.0	26.60	6.30	4.51 (+)	1.36 (+)
ML/HL	135	46.3–77.7	53.60	4.10	280	45.0–82.9	54.20	5.00	1.30 (–)	1.49 (+)
IL/HL	129	32.4–96.3	68.40	11.40	268	34.6–118.4	73.80	14.80	3.99 (+)	1.68 (+)
EsL/IL	127	7.8–48.1	18.00	6.30	268	4.6–46.2	19.80	7.50	2.49 (+)	1.42 (+)

***Tab. 7: Mean comparison of morphometric indexes between male and female** L. piscatorius.*
***Tab. 7: Srednja primerjava morfometričnih indeksov med samci in samicami vrste** L. piscatorius.*

Index	Males				Females				Student's *t* test	Snedecor's *F* test
	n	range	mean	SD	n	range	mean	SD		
SL/TL	34	64.3–84.4	81.70	3.20	76	64.5–85.5	82.30	2.30	0.98 (–)	1.93 (+)
BD/SL	34	3.7–10.0	6.50	1.08	76	3.6–9.3	6.70	1.70	0.74 (–)	2.47 (+)
HL/SL	34	35.0–40.6	37.50	1.30	76	26.5–48.5	38.10	2.30	1.78 (–)	3.13 (+)
PPectL/SL	34	39.6–46.1	43.30	1.70	76	36.8–56.8	43.80	2.80	1.15 (–)	2.71 (+)
PD1/SL	34	7.8–16.0	11.80	1.50	76	9.0–16.1	11.90	1.30	0.37 (–)	1.33 (–)
PD2/SL	34	61.8–67.0	63.90	1.30	76	6.0–77.4	64.80	2.20	3.12 (+)	1.51 (–)
PPelL/SL	34	21.3–30.3	25.70	1.80	76	21.1–28.8	25.80	1.60	0.28 (–)	1.26 (–)
PaL/SL	34	64.1–72.7	68.60	1.90	76	57.0–83.3	68.90	3.10	0.62 (–)	2.66 (+)
PecL/SL	34	14.2–29.1	23.20	3.10	76	15.9–30.6	22.80	3.20	0.62 (–)	1.06 (–)
PecH/SL	34	15.4–20.3	17.40	1.10	76	14.7–25.9	18.30	1.60	3.42 (+)	2.11 (+)
IL/SL	33	20.7–40.6	32.00	4.80	74	16.6–55.1	30.10	6.00	1.74 (–)	1.56 (–)
ED/HL	34	8.4 –26.3	12.30	3.00	76	7.3–35.8	12.90	3.20	0.95 (–)	1.14 (–)
PrOL/HL	34	42.4–66.3	51.40	5.23	76	38.6–77.0	50.80	5.21	0.56 (–)	1.01 (–)
PsOL/HL	34	26.5–39.4	32.80	3.50	76	23.7–54.7	33.90	4.50	1.39 (–)	1.65 (+)
IOL/HL	34	17.0–37.1	25.60	4.10	76	19.4–41.0	25.90	4.90	0.33 (–)	1.43 (–)
ML/HL	34	45.5–61.4	54.80	3.40	76	43.0–79.2	55.20	4.20	0.53 (–)	1.53 (–)
IL/HL	33	53.7–114.0	85.10	14.10	74	44.7–148.0	79.10	16.60	1.92 (–)	1.39 (–)
EsL/IL	33	11.9–53.9	29.10	8.60	73	17.7–53.9	31.80	7.60	1.55 (–)	1.28 (–)

DISCUSSION

The available data show that *Lophius piscatorius* and *Lophius budegassa* were not frequently landed throughout the year, but the peak occurred in June. Moreover, it appeared that *L. budegassa* is more abundantly fished than *L. piscatorius* off the Tunisian coast as well as in other marine Mediterranean areas (Ungaro *et al.*, 2002), although both species found sufficient food to develop and grow in Tunisian waters, probably due to their both original and ingenious mode of prey captures (Armstrong *et al.*, 1992).

Production of anglerfishes was not very important in relation to total fish production from Tunisian waters according to Bradaï (2000), probably due to the fact that their contribution is not included in statistics of fishery production from southern Tunisian waters. In contrast, off southern and central Africa, the Cape monk, *Lophius vomerinus* (Valenciennes, 1837) and the African angler *Lophius vaillanti* Regan, 1903 were abundantly landed in commercial trawl fisheries (Caruso, 1990; Maartens *et al.*, 1999). In 1997, for example, 10,430 and 7,640 tons of *L. vomerinus* respectively were landed from Namibia and South Africa (Anonymous, 1998). Both species have a wide bathymetric distribution, from shallow waters down to 800 m depth, accessible by performing fishing gears which, however, are not in use in Tunisian waters.

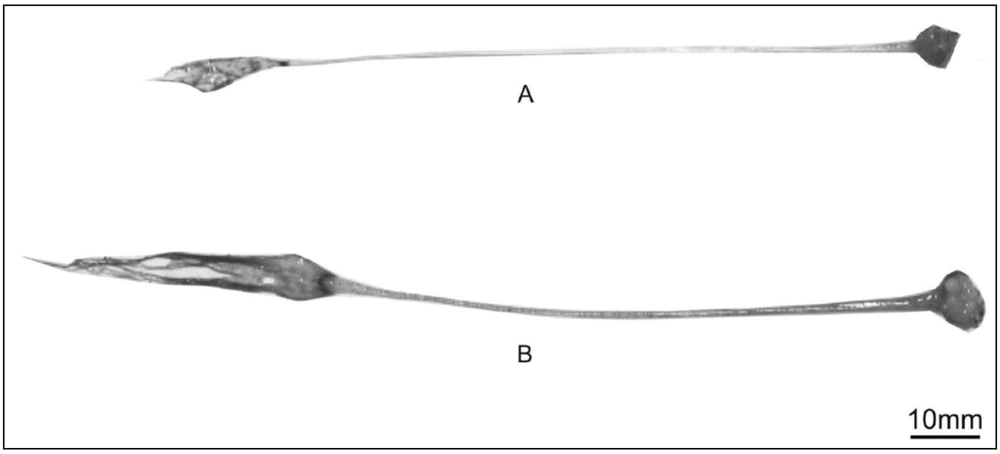


Fig. 6: Illicium. A.** L. budegassa **(FST-LOPH-budegassa-01), B.** L. piscatorius **(FST-LOPH-piscatorius-01).
Sl. 6: Kožni izrastek. A.** L. budegassa **(FST-LOPH-budegassa-01), B.** L. piscatorius **(FST-LOPH-piscatorius-01).

The available Tunisian specimens showed some significant differences in measurements that allow distinguishing *L. budegassa* from *L. piscatorius*. They also revealed sexual dimorphism between each species. We noted the presence of an interspecific variation concerning eleven morphometric indexes SL/TL, BD/SL, HL/SL, PPectL/SL, PD1/SL, PD2/SL, PPelL/SL, IL/SL, ML/HL, IL/HL and EsL/IL and three meristic counts such as number of rays in second dorsal fin, anal fin and number of vertebrae. The dimorphism was observed with regard to indexes morphometric such as PD2/SL and PecH/SL; in the opposite, no significant difference were recorded between males and females with special regard to the meristic counts above mentioned.

ACKNOWLEDGEMENTS

The authors thank two anonymous referees for helpful and useful comments that allowed us to improve the ms.

***Tab. 8: Mean comparison of morphometric indexes between** L. budegassa **and** L. piscatorius.*
***Tab. 8: Srednja primerjava morfometričnih indeksov med vrstama** L. budegassa **in** L. piscatorius.*

Index	*L. budegassa*				*L. piscatorius*				Student's	Snedecor's
	n	range	mean	SD	n	range	mean	SD	*t* test	*F* test
SL/TL	416	59.7–102.2	81.70	2.10	127	64.3–85.5	82.20	2.50	2.04 (+)	1.42 (+)
BD/SL	416	3.2–10.9	6.30	1.00	127	3.6–10.0	6.70	1.09	3.94 (+)	1.19 (+)
HL/SL	416	25.3–54.3	37.30	2.30	127	26.5–48.5	38.00	2.10	3.21 (+)	1.10 (+)
PPectL/SL	416	37.7–104.1	44.90	4.90	127	36.8–56.8	43.70	2.60	3.60 (+)	3.55 (+)
PD1/SL	416	5.9–64.1	11.00	3.00	127	7.2–16.1	11.90	1.40	4.67 (+)	4.59 (+)
PD2/SL	416	12.0–92.8	65.00	4.10	127	58.0–77.4	64.40	2.10	2.19 (+)	3.81 (+)
PPelL/SL	416	15.9–48.7	23.30	2.70	127	21.1–30.3	25.70	1.60	12.36 (+)	2.85 (+)
PaL/SL	416	56.5–97.2	68.60	2.90	127	40.3–83.3	68.40	3.70	0.56 (–)	1.63 (+)
PecL/SL	416	14.6–36.5	22.50	3.10	127	14.2–30.6	22.60	3.20	0.31 (–)	1.06 (+)
PecH/SL	416	13.9–28.1	18.30	1.60	127	14.7–25.9	18.00	1.50	1.94 (–)	1.14 (+)
IL/SL	398	11.8–42.3	26.80	4.80	124	10.4 –55.1	30.00	5.90	5.40 (+)	1.51 (+)
ED/HL	416	5.5–25.5	13.00	2.50	127	7.3–35.8	12.70	3.00	1.02 (–)	1.44 (+)
PrOL/HL	416	11.8–89.3	51.00	5.50	127	38.6–77.3	51.20	5.10	0.38 (–)	1.16 (+)
PsOL/HL	416	22.6–57.2	34.00	4.40	127	23.7–54.7	33.40	4.30	1.50 (–)	1.05 (+)
IOL/HL	416	11.6–57.0	25.70	6.10	127	1.7–41.0	25.90	4.70	0.39 (–)	1.68 (+)
ML/HL	416	45.0–82.9	54.00	4.70	127	4.3–79.2	55.00	4.20	2.28 (+)	1.25 (+)
IL/HL	398	32.4–118.4	72.10	14.00	124	28.9–148.2	79.10	16.50	4.27 (+)	1.39 (+)
EsL/IL	396	4.6–48.1	19.20	7.10	123	11.9–53.9	30.80	8.00	14.41 (+)	1.27 (+)

***Tab. 9: Mean comparison of meristic counts between** L. budegassa **and** L. piscatorius.*
***Tab. 9: Srednja primerjava merističnih štetij med vrstama** L. budegassa **in** L. piscatorius.*

Species	*L. budegassa*					*L. piscatorius*					Student's	Snedecor's
Character	n	range	mode	mean	SD	n	range	mode	mean	SD	*t* test	*F* test
Second dorsal	416	8–10	9	9.00	0.48	127	10–12	11	11.29	0.52	44.21 (+)	1.17 (+)
Pectoral	416	19–26	23	23.22	1.13	127	22–26	24	23.94	0.87	7.57 (+)	0.59 (–)
Anal	416	8–10	9	8.61	0.53	127	9–11	9	9.52	0.56	16.22 (+)	1.11 (+)
Vertebrae	416	24–28	26	25.63	0.77	127	27–31	29	29.27	0.80	45.27 (+)	1.07 (+)

***Tab. 10: Mean comparison of meristic counts between male and female of** L. budegassa **and of** L. piscatorius.*
***Tab. 10: Srednja primerjava merističnih štetij med samci in samicami vrst** L. budegassa **in** L. piscatorius.*

Sex	Males				Females				Student's	Snedecor's
Species/Character	**n**	**range**	**mean**	**SD**	**n**	**range**	**mean**	**SD**	***t* test**	***F* test**
L. budegassa										
Second dorsal fin	135	8–10	9.04	0.41	280	8–10	8.99	0.51	1.07 (–)	0.65 (–)
Pectoral fin	135	19–26	23.28	1.11	280	19–26	23.19	1.14	0.77 (–)	0.95 (–)
Anal fin	135	8–10	8.66	0.56	280	8–10	8.56	0.51	1.74 (–)	1.21 (+)
Vertebrae	135	24–27	25.61	0.77	280	24–28	25.63	0.76	0.25 (–)	0.97 (–)
L. piscatorius										
Second dorsal fin	34	10–12	11.17	0.39	76	10–12	11.34	0.55	1.85 (–)	1.99 (+)
Pectoral fin	34	22–25	23.79	0.88	76	22–26	24.00	0.86	1.16 (–)	0.95 (–)
Anal fin	34	9–10	9.53	0.51	76	9–11	9.56	0.57	0.27 (–)	1.25 (–)
Vertebrae	34	27–31	29.18	0.83	76	28–30	29.21	0.80	0.18 (–)	0.93 (–)

MORFOLOŠKI ZNAKI IN MERISTIČNA ŠTETJA PRI MALI MORSKI SPAKI *LOPHIUS BUDEGASSA* IN MORSKI SPAKI *L. PISCATORIUS* (OSTEICHTHYES: LOPHIIDAE), IZ OBREŽNIH TUNIZIJSKIH VODA (OSREDNJE SREDOZEMLJE)

Nawaim NEGZAOUI-GARALI & Mohamed BEN SALEM
Unité de Recherches Zoologie et Ecologie des Milieux aquatiques, Faculté des Sciences de Tunis,
Campus universitaire 2090 El Manar II, Tunis, Tunisie
E-mail: nawaim_negzaoui@yahoo.fr

Christian CAPAPÉ
Laboratoire d'Ichtyologie, case 104, Université Montpellier II, Sciences et Techniques du Languedoc, 34095 Montpellier cedex 05, France

POVZETEK

Avtorji opisujejo morfološke znake in meristična štetja, opravljena na malih morskih spakah Lophius budegassa *Spinola, 1807 in morskih spakah* L. piscatorius *Linnaeus, 1758,* ujetih v obrežnih vodah Tunizije. *Primerjave morfometričnih indeksov in merističnih štetij kažejo na določene medvrstne razlike in tudi na spolni dimorfizem pri obeh vrstah. Tako pozitivno kot redno povečanje dolžine kožnega izrastka pri obeh vrstah lahko pomeni izboljšavo v tej "ribolovni napravi" s posebnim ozirom na starost.*

Ključne besede: *Lophius budegassa, Lophius piscatorius,* morfomertični indeksi, meristična štetja, Tunizija, osrednje Sredozemlje

REFERENCES

Anonymous (1998): Fishing Industry Handbook (South Africa, Namibia and Mozambique), 26th Ed. 438 p.

Armstrong, M. P., J. A. Musick & J. A. Colvocoresses (1992): Age, growth, and reproduction of the goosefish *Lophius americanus* (Pisces: Lophiiformes). Fish. Bull., 90, 217–230.

Ben Othman, S. (1971): Observations hydrologiques, dragage et chalutage dans le sud-est tunisien. Bull. Inst. Natl. Sci. Tech. Oceanogr. Peche. Salammbo, 2(2), 103–120.

Ben Othman, S. (1973): Le Sud tunisien (golfe de Gabès), hydrologie, sédimentologie, flore et faune. Ph.D. Thesis. University of Tunis, 166 p.

Bradaï, M. N. (2000): Diversité du peuplement ichtyque et contribution à la connaissance des sparidés du golfe de Gabès. Ph.D. Thesis. University of Sfax, 600 p.

Bradaï, M. N., J. P. Quignard, A. Bouain, O. Jarboui, A. Ouannes-Ghorbel, L. Ben Abdallah, J. Zaouali & S. Ben Salem (2004): Ichtyofaune autochtone et exotique des côtes tunisiennes: Recensement et biogéographie. Cybium, 28(4), 315–328.

Caruso, J. H. (1986): Lophiidae. In: Whitehead, P. J. P., M. L. Bauchot, J. C. Hureau, J. Nielsen & E. Tortonese (eds.): Fishes of the North-Eastern Atlantic and the Mediterranean. UNESCO, Paris. Vol. 3, pp. 1362–1363.

Caruso, J. H. (1990): Lophiidae. In: Quéro, J. C., J. C.Hureau, C. Karrer, A. Post & L. Saldanha (eds.): Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). JNICT, Lisbon; SEI, Paris; and UNESCO, Paris. Vol. 1, pp. 479–480.

Collignon, J & H. Aloncle (1972): Catalogue raisonné des poissons des mers marocaines. I. Cyclostomes, Sélaciens, Holocéphales. Bull. Inst. Pech. Maroc, 19, 1–164.

Dieuzeide, R., M. Novella & J. Roland (1954): Catalogue des poissons des côtes algériennes. Bull. Stn. Aquic. Pêche Castiglione, n.s., 6, 1–384.

Ktari-Chakroun, F. & A. Azouz (1971): Les fonds chalutables de la région sud-est de la Tunisie (golfe de Gabès). Bull. Inst. Natl. Sci. Tech. Oceanogr. Peche. Salammbo, 2(1), 5–48.

Maartens, L., A. J. Booth & T. Hecht (1999): The growth of monkfish *Lophius vomerinus* in Namibian waters, with a comparison of otolith and illicia methods of ageing. Fish. Res., 44, 139–148.

Ungaro, N., G. Marano, R. Auteri, A. Voliani, E. Massutí, M. García-Rodríguez & K. Osmani (2002): Distribution, abundance and biological features of anglerfish *(Lophius piscatorius and Lophius budegassa)* (Osteichthyes: Lophiiformes) in the Mediterranean Sea. Sci. Mar., 66 (suppl. 2), 55–63.

Original scientific article
Received: 2008-06-03

UDC 599.51/.53(262.3-13)

CETACEAN STRANDINGS IN THE PROVINCE OF BRINDISI (ITALY, SOUTHERN ADRIATIC SEA)

Paola PINO D'ASTORE
I-72100 Brindisi, Via del Lavoro 21B, Italy
E-mail: astorepaola@virgilio.it

Giovanni BEARZI & Silvia BONIZZONI
Tethys Research Institute, I-20121 Milano, Viale G.B. Gadio 2, Italy

ABSTRACT

Relatively little is known about the cetacean fauna inhabiting the southern Adriatic Sea. Cetacean strandings are therefore an important source of information to gain insight on the species inhabiting these waters. Between January 2002 and May 2008, a total of 46 cetacean stranding events were recorded in the Province of Brindisi, on the south-eastern coast of Apulia, Italy, over approximately 100 km of coastline. Strandings always concerned single individuals and included 2 Cuvier's beaked whale Ziphius cavirostris*, 16 common bottlenose dolphins* Tursiops truncatus*, 9 striped dolphins* Stenella coeruleoalba*, 4 small Delphinidae (most likely* S. coeruleoalba*), 11 small Delphinidae, and 4 unknown cetacean species. This dataset complements information recorded by the Italian Centre for Cetacean Studies since 1986, confirming that common bottlenose dolphins and striped dolphins are the cetacean species predominantly found stranded in the Province of Brindisi. The two findings of Cuvier's beaked whale are new records for this sector of the Apulian coast. The first animal was found on February 22nd, 2003, with its rear part possibly cut off by a ship's propeller. The second stranded on July 6th, 2003. Absence of confirmed records of short-beaked common dolphins* Delphinus delphis *corroborates the presumption that the species is now rare or absent in this part of the Mediterranean Sea.*

Key words: cetaceans, strandings, southern Adriatic Sea, Brindisi, Italy

SPIAGGIAMENTI DI CETACEI NELLA PROVINCIA DI BRINDISI (ITALIA, MARE ADRIATICO MERIDIONALE)

SINTESI

La fauna cetologica dell'Adriatico meridionale è relativamente poco conosciuta. Pertanto, gli spiaggiamenti di cetacei costituiscono un'importante fonte di informazioni per conoscere meglio le specie che vivono in queste acque. Nella Provincia di Brindisi, sulla costa sud-orientale della Puglia (Italia) abbiamo registrato un totale di 46 spiaggiamenti di cetacei da gennaio 2002 a maggio 2008, su un tratto di costa di circa 100 km. Gli spiaggiamenti, sempre relativi a singoli individui, comprendono 2 zifii Ziphius cavirostris*, 16 tursiopi* Tursiops truncatus*, 9 stenelle striate* Stenella coeruleoalba*, 4 piccoli Delphinidae (probabilmente* S. coeruleoalba*), 11 piccoli Delphinidae, e 4 cetacei di specie ignota. Questo dataset integra le informazioni registrate dal Centro Studi Cetacei a partire dal 1986, confermando che il tursiope e la stenella striata sono le principali specie che spiaggiano nella Provincia di Brindisi. I due ritrovamenti di zifio costituiscono nuove segnalazioni per questo settore della costa pugliese. Il primo individuo è stato ritrovato il 22 febbraio 2003 con la parte posteriore del corpo mancante e forse amputata dall'elica di una nave. Il secondo individuo è stato esaminato il 6 luglio 2003. L'assenza di ritrovamenti di delfino comune* Delphinus delphis *conferma che in questa parte del Mediterraneo la specie è oggi rara o del tutto assente.*

Parole chiave: cetacei, spiaggiamenti, mare Adriatico meridionale, Brindisi, Italia

INTRODUCTION

Relatively little is known about the cetacean fauna inhabiting the southern Adriatic Sea. Research at sea in this area has been scant and mostly limited to short-term or opportunistic sighting campaigns. Cetacean strandings are therefore an important source of information to gain insight on the species inhabiting these waters and the threats that may be affecting them.

In the Province of Brindisi, south-east Italy, an important dataset was collected and published by the Italian Centre for Cetacean Studies (Centro Studi Cetacei 1987-2004; Podestà & Bortolotto, 2001; Centro Studi Cetacei Onlus & Museo Civico di Storia Naturale di Milano, 2004, 2006a, 2006b), documenting a total of 77 cetacean strandings recorded between February 1987 and July 1995. After 1995, a single event was reported, involving an unknown cetacean species stranded in June 2003.

Since January 2002, cetacean stranding events in the Province of Brindisi have been recorded systematically based on an independent private initiative by the first author, a biologist engaged in the protection and recovery of wild fauna. Collaboration with cetacean experts from the Tethys Research Institute, initiated in 2007, contributed to bringing to light a remarkable dataset of 46 cetacean strandings, presented here prior to inclusion in the Italian Stranding Data Bank, an online database created in 2007 and managed by the Interdisciplinary Centre for Bioacoustics and Environmental Research, University of Pavia, and by the Milan National History Museum.

MATERIAL AND METHODS

The study area is located in the southern Adriatic Sea, on the south-eastern coast of Apulia, Italy. Monitoring effort uniformly covered the whole Province of Brindisi, between Torre Egnazia and Lendinuso, totalling approximately 100 km of coastline (Fig. 1). This area includes both rocky and sandy shores. It is a highly patrolled portion of the Italian coast where strandings of

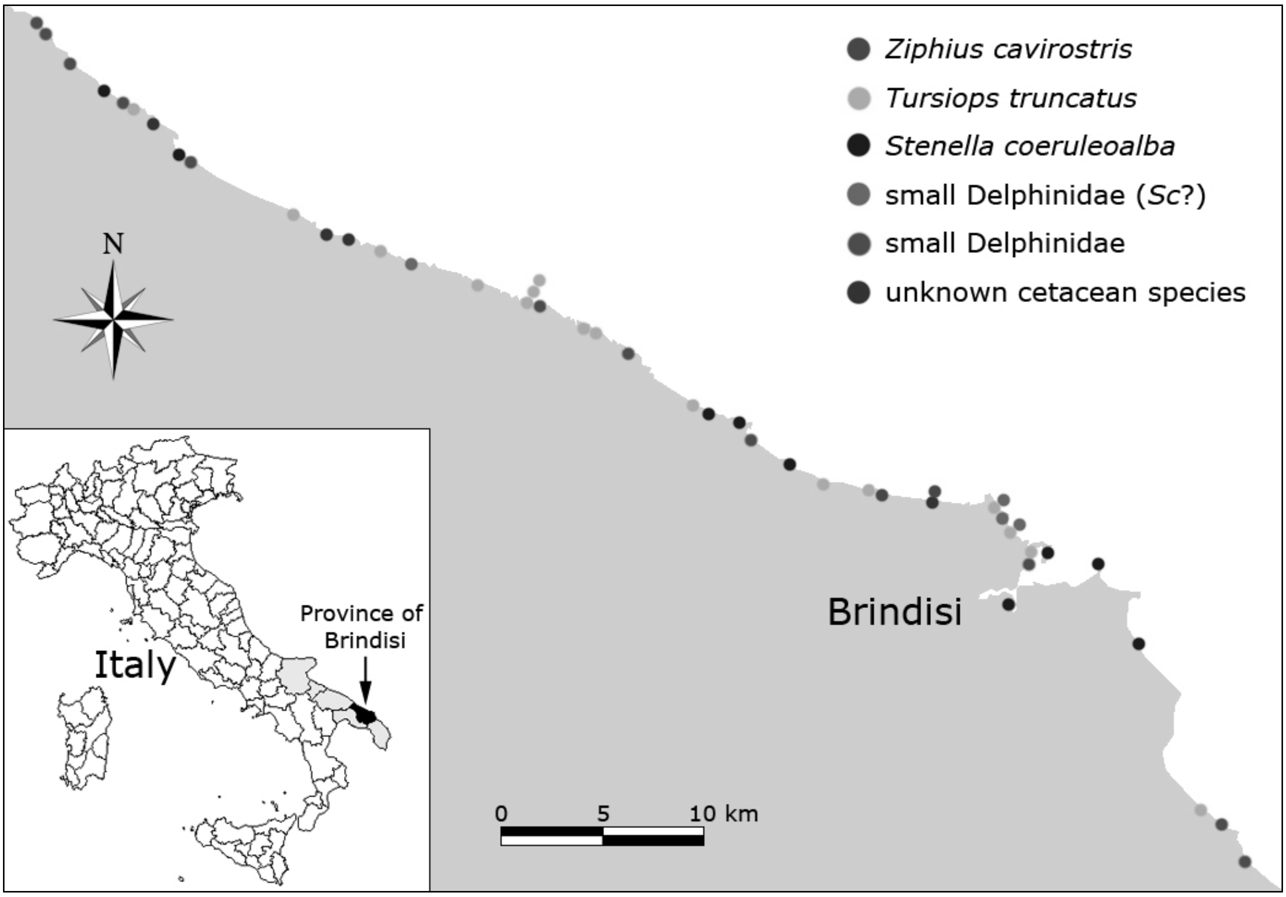


Fig. 1: Study area with the location of 46 cetacean strandings recorded between January 2002 and May 2008. The location of the Province of Brindisi relative to Italy is shown in the inset.
Sl. 1: Preučevano območje s 46 lokacijami, na katerih so med januarjem 2002 in majem 2008 nasedle različne vrste kitov. V okviru levo spodaj je prikazana lega province Brindisi na celotnem zemljevidu Italije.

cetaceans and other marine megafauna can hardly go unnoticed, regardless of the season. Year-round coverage of the study area was granted by an information network established by the first author, including local authorities, veterinarian officers, private citizens and a number of other collaborators (see Acknowledgements) who have been providing timely reports over the years. In addition to cetacean strandings, information collected between January 2002 and May 2008 in the context of this study included 214 records of stranded sea turtles (212 loggerhead *Caretta caretta* and two green turtles *Chelonia mydas)*.

Information collected was carefully scrutinized to eliminate reporting biases. Species identification was based on photographic documentation and other clear-cut evidence. Uncertainty in species identification resulted in cautionary rather than unwarranted attributions. However, identification only took into account species known to occur in the Mediterranean Sea (Notarbartolo di Sciara & Demma, 1997; Reeves & Notarbartolo di Sciara, 2006).

Uncertainty involved primarily small dolphins of 2 m total length (TL) or less, in advanced decomposition, having a rostrum and about 35-50 teeth in each jaw. These could be either striped dolphins *Stenella coeruleoalba* or short-beaked common dolphins *Delphinus delphis*. As the latter species was never found stranded in the Province of Brindisi and has declined dramatically in central Mediterranean waters (see Discussion), uncertain species with the attributes mentioned above were classified as 'small Delphinidae (most likely *S. coeruleoalba*)'. If information about key identification features was absent, dolphin-like carcasses were classified as 'small Delphinidae'. Body length was not considered as a reliable feature to discriminate between the two categories above, considering that a small carcass could also be of a young common bottlenose dolphin *Tursiops truncatus* specimen.

RESULTS

Between January 2002 and May 2008, a total of 46 cetacean stranding events were recorded. Of these, 36 carcasses were inspected by the first author, 8 by veterinarian officers of the Brindisi Local Sanitary Unit (ASL BR01) deputed to carcass disposal, and two by private citizens. Information on 10 animals not directly inspected by the first author was obtained based on interviews conducted immediately after the inspection. In these cases, species identification could never be confirmed. Photos useful for identification purposes were available for 30 of the 46 records. In a few cases, species identification was confirmed through osteological inspection, particularly of the palatal bones that allow discrimination between striped and short-beaked common dolphins (Notarbartolo di Sciara & Demma, 1997).

Strandings were always of single individuals and included 2 Cuvier's beaked whale *Ziphius cavirostris*, 16 common bottlenose dolphins, 9 striped dolphins, 4 small Delphinidae (most likely *S. coeruleoalba),* 11 small Delphinidae, and 4 unknown cetacean species (Tab. 1). The distribution of these strandings in the study area is shown in figure 1. Table 1 provides the precise location and other relevant information.

The relative distribution of cetacean strandings by species is shown in figure 2. Common bottlenose dolphins and striped dolphins were the most abundant records. These two species are also likely to be included in the 'small Delphinidae' component, although in unknown percentages. Figure 3 shows the annual distribution of cetacean strandings by species, while figures 4 and 5 their overall annual and monthly occurrence.

The two findings of Cuvier's beaked whale are new records for the Province of Brindisi. The first animal was found stranded near Giancola, Contrada Lupia, on February 22nd, 2003, with its rear part missing and possibly cut off by a ship's propeller (Fig. 6). The foresection was 2.05 m long. This animal was fresh and either a female or a young male based on teeth not protruding from the lower jaw (the genital area was in the missing part of the body and could not be inspected).

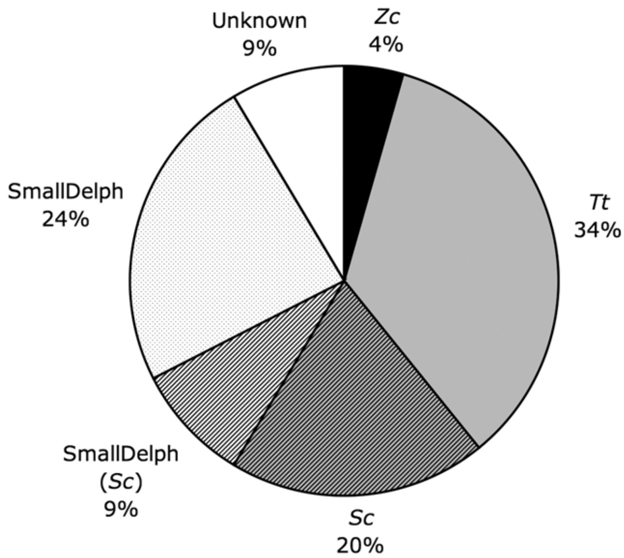


Fig. 2: Relative distribution of cetacean strandings by species. *Zc = Ziphius cavirostris,* *Tt = Tursiops truncatus,* *Sc = Stenella coeruleoalba,* ***SmallDelph** (Sc)* ***= small Delphinidae (most likely*** *S. coeruleoalba),* ***SmallDelph = small Delphinidae.***

Sl. 2: Relativna razporeditev nasedlih kitov po posameznih vrstah. *Zc = Ziphius cavirostris,* *Tt = Tursiops truncatus,* *Sc = Stenella coeruleoalba,* ***SmallDelph** (Sc)* ***= male pliskavke Delphinidae (po vsej verjetnosti*** *S. coeruleoalba),* ***SmallDelph = male pliskavke Delphinidae.***

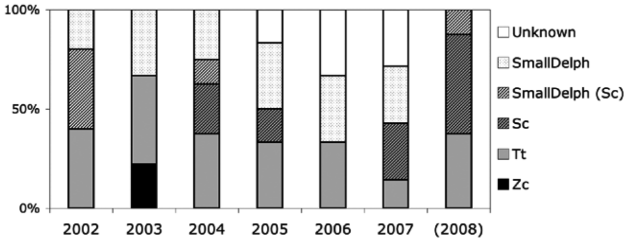


Fig. 3: Relative annual distribution of cetacean strandings by species. While years 2002–2007 refer to a 12-month annual coverage (January-December), the (2008) bar indicates the number of strandings recorded during 5 months (January-May).
Sl. 3: Relativna letna razporeditev kitov, nasedlih po posameznih vrstah. Medtem ko obdobje 2002–2007 zadeva 12-mesečno letno pokrovnost (januar-december), stolpič (2008) ponazarja število kitov, nasedlih v obdobju petih mesecev (januar-maj).

The second Cuvier's beaked whale was found near Acque Chiare on July 6th, 2003. This animal, found in relatively advanced decomposition, was 5.12 m long and a male based on teeth protruding from the lower jaw (Fig. 7).

DISCUSSION

Cetacean strandings along the Italian coasts have been recorded by the Italian Centre for Cetacean Studies since 1986 (Centro Studi Cetacei 1987-2004; Podestà & Bortolotto, 2001; Centro Studi Cetacei Onlus & Museo Civico di Storia Naturale di Milano, 2004, 2006a, 2006b). The published dataset includes 77 stranding events recorded in the Province of Brindisi. A striped dolphin stranded in Costa Merlata on August 30th, 1991, was attributed to the Province of Bari, but the location lies in the Province of Brindisi.

In 2007, this information was included and made available online in the Italian Stranding Data Bank (http://www-1.unipv.it/cibra/spiaggiamenti.html), together with data provided by other project partners. An additional record of a common bottlenose dolphin stranded in Torre Canne on November 11th, 1986, can be found in the Stranding Data Bank at the date of writing.

Most records in the dataset by the Italian Centre for Cetacean Studies (N=37) are striped dolphins found in 1991, when these animals stranded in large numbers along the coasts of Apulia and other parts of southern Italy, largely as a consequence of a die-off occurred between 1990 and 1992 over large portions of the Mediterranean region, from Spain to Turkey. The die-off predominantly affected striped dolphins and was caused by a morbillivirus infection of unknown origin (Bortolotto *et al.*, 1992; Aguilar & Raga, 1993; Aguilar, 2000).

Records by the Italian Centre for Cetacean Studies include one fin whale *Balaenoptera physalus* stranded in Carovigno in August 3rd, 1991, and two Risso's dolphins *Grampus griseus* (Torre San Gennaro, June 6th, 1987; Lendinuso, November 21st, 1994). All other animals are either common bottlenose dolphins or striped dolphins, with a few strandings of unknown species.

Cardellicchio *et al.* (2000) reported 31 striped dolphins, two common bottlenose dolphins and two Risso's dolphins stranded between 14 February and 30 June 1987 along the southern coasts of Apulia, including in the Province of Brindisi (based on the article's map). Similarly, Decataldo *et al.* (2004) reported 10 striped dolphins and three common bottlenose dolphins stranded between April 1991 and March 1999 in south-

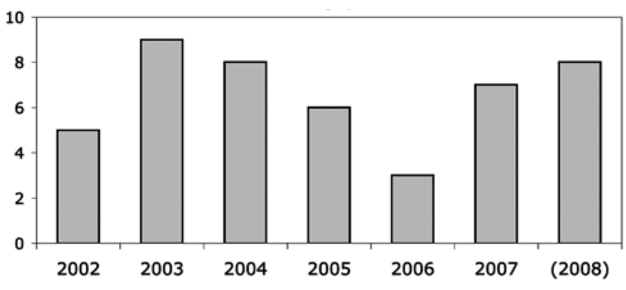


Fig. 4: Number of cetacean strandings by year. While years 2002–2007 refer to a 12-month annual coverage (January-December), the (2008) bar indicates the number of strandings recorded during 5 months (January-May).
Sl. 4: Število kitov, nasedlih po posameznih letih. Medtem ko obdobje 2002–2007 zadeva 12-mesečno letno pokrovnost (januar-december), stolpič (2008) ponazarja število kitov, nasedlih v obdobju petih mesecev (januar-maj).

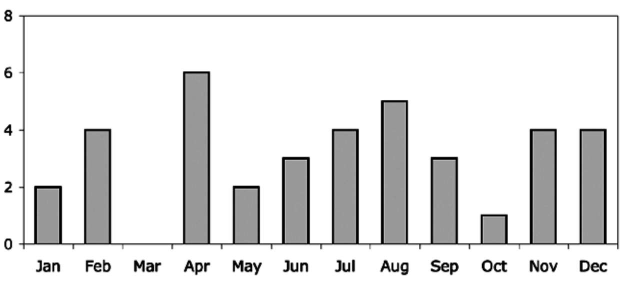


Fig. 5: Number of cetacean strandings by month, 2002–2007. Strandings recorded between January and May 2008 are not included.
Sl. 5: Število kitov, nasedlih po posameznih mesecih v obdobju 2002–2007. Grafikon ne vključuje kitov, nasedlih med januarjem in majem 2008.

Fig. 6: Cuvier's beaked whale stranded near Giancola on February 22nd, 2003, possibly killed by a ship's propeller.
Sl. 6: Cuvierjev kljunati kit, ki je 22. februarja 2003 nasedel v bližini Giancole; po vsej verjetnosti žrtev ladijskega vijaka.

eastern Apulia, including in the Province of Brindisi (based on the article's map). As the precise location is not given, these records may or may not be entirely included in the Italian Stranding Data Bank. Troncone *et al.* (1990) reported a total of 85 cetacean strandings occurring along the coasts of Apulia between 1987 and 1990. While most of these events are also included in the reports by the Italian Centre for Cetacean Studies (with minor discrepancies), two strandings in the Province of Brindisi were not published there: a common bottlenose dolphin of 2.16 m TL stranded in Torre Canne on November 11th, 1988, and another common bottlenose dolphin of 2.04 m TL stranded in Torre Guaceto on March 19th, 1990. In addition, there is a record of a common bottlenose dolphin of 2.16 m TL stranded in Torre Canne on June 26th, 1988, included in a report by the Region of Apulia (Anonymous, 1989). To our knowledge, since 1996 only one stranding in the Province of Brindisi has been published: an unknown cetacean of about 1.8 m TL stranded in Torchiarolo on June 12th, 2003 (Centro Studi Cetacei Onlus & Museo Civico di Storia Naturale di Milano, 2004).

The dataset presented here (January 2002 – May 2008) is largely consistent with the published information and additional stranding records available online, and it confirms that common bottlenose dolphins and striped dolphins are the cetacean species predominantly found stranded in the Province of Brindisi. This is not unexpected based on the available information on cetaceans inhabiting the southern Adriatic Sea (*e.g.*, Notarbartolo di Sciara *et al.*, 1993; Bearzi *et al.*, 2004; Manoukian *et al.*, 2004). The steep continental slope near the coast and the deep waters of the southern portion of the Adriatic Sea (Fig. 8) are an ideal habitat for a pelagic species such as the striped dolphin (Notarbartolo di Sciara & Demma, 1997; Aguilar, 2000). On the other hand, common bottlenose dolphins may be either animals living on the narrow continental shelf and continental slope off south-eastern Apulia, or animals coming from farther away (including from the shallower central and northern Adriatic, south-eastern Adriatic coasts and western Greece, where habitat is suitable and the species reportedly is regular; Bearzi *et al.*, *in press).*

The two findings of Cuvier's beaked whale reported here are new records for the Province of Brindisi. However, they are not unexpected. Other strandings of this species along the eastern coast of Apulia (also see Holcer *et al.*, 2006) include: 1) Monopoli (Bari), June 6th, 1980, male, 5 m (Bello, 1990); 2) Bari, February 15th, 1982, 5.8 m (Podestà *et al.*, 2006); 3) Mola di Bari (Bari), May 22nd, 1986, female, 3.3 m (Centro Studi Cetacei, 1987); 4) Bisceglie (Bari), October 12th, 1992, female,

Fig. 7: Cuvier's beaked whale stranded near Acque Chiare on July 6th, 2003.
Sl. 7: Cuvierjev kljunati kit, ki je 6. julija 2003 nasedel v bližini kraja Acque Chiare.

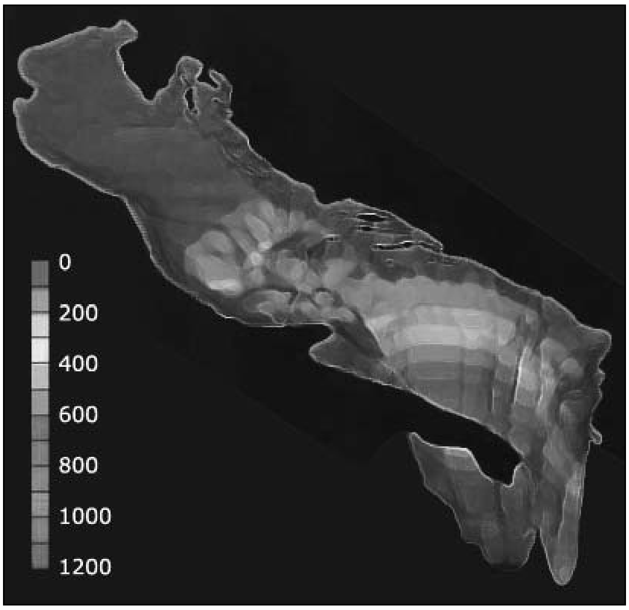


Fig. 8: 3-D topography of the Adriatic Sea showing the extension of continental shelf and pelagic waters. Modified from Dr. Christopher E. Naimie, Dartmouth College, Hanover, NH, USA (http://thayer.dartmouth.edu/adriatic/bathymetry.html).
Sl. 8: Tridimenzionalna topografija Jadranskega morja s podaljškom celinske police (šelfa) in pelagičnimi vodami. Prirejeno po Dr. Christopherju E. Naimieju, Dartmouth College, Hanover, NH, USA (http://thayer.dartmouth.edu/adriatic/bathymetry.html).

5.3 m (Centro Studi Cetacei, 1995); 5) Vernole (Lecce), March 26th, 2002; and 6) Morciano di Leuca (Lecce), April 12th, 2002. In addition to these, Storelli *et al.* (1999) report the stranding of a 5.3 m female Cuvier's beaked whale 'along the Apulian coast' between June and September 1996.

The additional two strandings reported in this study, and particularly that of a fresh mutilated animal (the other carcass was decomposed and may have been floating adrift for a long time before stranding), are consistent with the hypothesis that the southern Adriatic Sea is an important habitat for this species (Holcer *et al.*, 2006).

Only one sighting of short-beaked common dolphins in southern Adriatic waters has been reliably reported in the recent peer-reviewed literature (four animals sighted off south-eastern Apulia on September 3rd, 1990; Angelici & Marini, 1992). Common dolphins have declined considerably in central Mediterranean waters over the past decades and only a few relic groups may remain (Bearzi *et al.*, 2003, 2004, 2008). Absence of confirmed records of short-beaked common dolphins in the present study corroborates that the species is now rare or absent in this part of the Mediterranean Sea.

Evidence of human induced mortality as reported in Table 1 is likely underestimated, as such evidence could hardly be recorded in decomposed, mummified or in other ways incomplete specimens. Moreover, the carcasses in this study were not subject to specific inspection in order to detect evidence of bycatch in fishing gear (*e.g.*, Kuiken, 1996).

Tab. 1: Cetaceans stranded in the Province of Brindisi between January 2002 and May 2008.
Legend: (*) Body condition code based on Kuiken & Hartmann (1991); PPdA = Paola Pino d'Astore; V = veterinarian officer of Brindisi Local Sanitary Unit (ASL BR01); P = private citizen.
Tab. 1: Kiti, nasedli med januarjem 2002 in majem 2008 na obrežju province Brindisi.
Legenda: (*) Oznaka telesnega stanja po Kuiken & Hartmann (1991); PPdA = Paola Pino d'Astore; V = veterinarski uslužbenec Lokalne sanitarne enote v provinci Brindisi (ASL BR01); P = zasebni državljan.

Date reported	Date inspected	Location	Lat. (N)	Long. (E)	Circumstances	Inspector	Species	Gender	Length (cm)	Body condition	Body condition code (*)	Notes
4.1.2002	4.1.2002	Lamaforca, Ostuni	40°46'03"	17°40'29"	Stranded (sand)	PPdA	Tt	Unknown	271 (measured)	Decomposed	Not recorded	
16.4.2002	16.4.2002	Contrada Betlemme, Brindisi	40°40'28"	17°56'47"	Stranded (sand)	PPdA	SmallDelph (Sc?)	Unknown	185 (measured)	Decomposed	Not recorded	
22.4.2002	22.4.2002	Contrada Betlemme, Brindisi	40°40'10"	17°56'50"	Stranded (rocks)	PPdA	SmallDelph (Sc?)	Unknown	185 (measured)	Decomposed	Not recorded	
26.4.2002	26.4.2002	Torre Guaceto, Carovigno	40°42'54"	17°48'02"	Stranded (rocks)	PPdA	SmallDelph	Unknown	<200 (estimated)	Decomposed	4	
13.11.2002	13.11.2002	Punta Penna Grossa, Carovigno	40°43'27"	17°46'02"	Stranded (sand)	PPdA	Tt	Unknown	290 (measured)	Decomposed	4	

Date reported	Date inspected	Location	Lat. (N)	Long. (E)	Circumstances	Inspector	Species	Gender	Length (cm)	Body condition	Body condition code (*)	Notes
22.2.2003	22.2.2003	Giancola, Brindisi	40°41'05"	17°52'37"	Stranded (sand)	PPdA	Zc	F?	205 (foresection only, measured)	Decomposed	3	Rear part of the body missing and possibly cut off by a large ship's propeller.
25.6.2003	25.6.2003	Lendinuso, Torchiarolo	40°31'30"	18°04'52"	Stranded (sand)	P	SmallDelph	Unknown	Unknown	Decomposed	Not recorded	
28.6.2003	28.6.2003	Lamaforca, Ostuni	40°46'05"	17°40'29"	Stranded (rocks)	PPdA	Tt	M	300 (measured)	Fresh	2	Abandoned in situ. On June 30th, 2003, re-stranded further south on a sandy beach near Specchiolla, Carovigno, 40 44 08 N 17 44 36 E. Re-inspected by PPdA.
6.7.2003	6.7.2003	Forcatella - Torre Canne, Fasano	40°51'16"	17°26'37"	Stranded (sand)	V	SmallDelph	Unknown	300 (measured)	Decomposed	5	
6.7.2003	6.7.2003	Acque Chiare, Brindisi	40°40'55"	17°54'11"	Stranded (sand)	PPdA	Zc	M	512 (measured)	Decomposed	4	
1.8.2003	1.8.2003	Sciaia a Mare, Brindisi	40°39'50"	17°57'27"	Stranded (rocks)	PPdA	Tt	Unknown	75 (measured)	Decomposed	4	
2.8.2003	2.8.2003	Specchiolla, San Vito dei Normanni	40°44'45"	17°43'48"	Stranded (sand)	P	SmallDelph	Unknown	Unknown	Decomposed	Not recorded	
11.11.2003	12.11.2003	Forcatella, Fasano	40°46'03"	17°40'29"	Stranded (sand)	PPdA	Tt	Unknown	170 (measured)	Fresh	2	
30.1.2004	30.1.2004	Contrada Betlemme, Brindisi	40°40'10"	17°56'50"	Stranded (sand)	PPdA	Tt	Unknown	256 (measured)	Decomposed	4	
8.2.2004	8.2.2004	Creta Rossa, Ostuni	40°47'09"	17°36'31"	Stranded (sand)	PPdA	SmallDelph (Sc?)	Unknown	200 (measured)	Decomposed	4	
12.2.2004	12.2.2004	Pantanagianni, Carovigno	40°45'17"	17°42'48"	Stranded (sand)	PPdA	Tt	Unknown	290 (measured)	Decomposed	4	
17.2.2004	18.2.2004	Apani, Brindisi	40°41'60"	17°49'04"	Stranded (sand)	PPdA	Sc	F	116 (measured)	Fresh	2	Necropsy by Prof. Nicola Zizzo, University of Bari.
12.4.2004	12.4.2004	Costa Merlata, Ostuni	40°46'31"	17°38'55"	Stranded (rocks)	PPdA	Tt	Unknown	318 (measured)	Fresh	2	
11.7.2004	11.7.2004	Porto di Villanova, Ostuni	40°47'33"	17°35'18"	Stranded (rocks)	PPdA	Tt	Unknown	272 (measured)	Decomposed	Not recorded	
15.8.2004	15.8.2004	Torre Canne, Fasano	40°49'58"	17°28'18"	Stranded (sand)	PPdA	Sc	M	153 (measured)	Fresh	2	Stranded alive. Necropsy by Prof. Nicola Zizzo, University of Bari.
23.8.2004	23.8.2004	Torre Egnazia, Fasano	40°53'16"	17°23'34"	Stranded (sand)	V	SmallDelph	Unknown	270 (estimated)	Fresh	Not recorded	Flukes reportedly cut off with a clear cut.
12.9.2004	12.9.2004	Torre Egnazia, Fasano	40°53'16"	17°23'34"	Stranded (sand)	V	SmallDelph	Unknown	300 (estimated)	Decomposed	Not recorded	
2.4.2005	2.4.2005	Savelletri, Fasano	40°51'32"	17°25'59"	Stranded (rocks)	PPdA	Sc	F	210 (measured)	Fresh	2	
5.8.2005	5.8.2005	Punta Penne, Brindisi	40°40'58"	17°56'08"	Stranded (sand)	PPdA	Tt	M	240 (measured)	Decomposed	4	
16.9.2005	16.9.2005	Torre Santa Sabina, Carovigno	40°46'04"	17°40'43"	Stranded (rocks)	PPdA	SmallDelph	Unknown	185 (measured)	Decomposed	Not recorded	
21.9.2005	21.9.2005	Torre Egnazia, Fasano	40°51'16"	17°26'37"	Stranded (sand)	PPdA	Tt	M	293 (measured)	Decomposed	4	
6.11.2005	6.11.2005	Mater Domini, Brindisi	40°39'38"	17°57'29"	Stranded (sand)	PPdA	SmallDelph	Unknown	170 (measured)	Decomposed	4	
30.12.2005	30.12.2005	Monticelli, Ostuni	40°47'45"	17°34'06"	Stranded (sand)	V	Unknown	Unknown	Unknown	Decomposed	Not recorded	
1.7.2006	1.7.2006	Acque Chiare, Brindisi	40°40'55"	17°54'12"	Stranded (sand)	V	Unknown	Unknown	110 (estimated)	Decomposed	Not recorded	

Date reported	Date inspected	Location	Lat. (N)	Long. (E)	Circum-stances	Inspec-tor	Species	Gender	Length (cm)	Body condition	Body condi-tion code (*)	Notes
11.10.2006	11.10.2006	Giancola, Brindisi	40°41′12"	17°52′02"	Stranded (sand)	PPdA	Tt	Un-known	226 (measured)	Decom-posed	4	
24.12.2006	24.12.2006	Torre Canne, Fa-sano	40°49′57"	17°28′21"	Stranded (sand)	V	SmallDelph	Un-known	200 (esti-mated)	Decom-posed	Not re-corded	
9.4.2007	9.4.2007	Campo di Mare, Tor-chiarolo	40°32′35"	18°04′02"	Stranded (rocks)	PPdA	SmallDelph	Un-known	200 (esti-mated)	Decom-posed	5	
3.5.2007	3.5.2007	Porto in-terno Brin-disi, Brindisi	40°38′07"	17°56′59"	Drifting in port	PPdA	Sc	M	206 (measured)	Fresh	2	In April 29th, 2007, a dolphin was reported alive in the port of Brindisi. Possibly the same individual.
11.5.2007	11.5.2007	Pilone, Os-tuni	40°48′23"	17°32′15"	Stranded (rocks)	PPdA	Tt	F	200 (measured)	Decom-posed	4	
11.6.2007	12.6.2007	Forcatelle, Fasano	40°52′15"	17°24′48"	Stranded (sand)	PPdA	SmallDelph	Un-known	200 (measured)	Decom-posed	4	
8.11.2007	8.11.2007	Rosa Ma-rina, Ostuni	40°4752"	17°33′36"	Stranded (sand)	V	Unknown	Un-known	70 (esti-mated)	Decom-posed	Not re-corded	
8.12.2007	8.12.2007	Isole Peda-gne, Brindisi	40°39′18"	17°59′56"	Stranded (rocks)	PPdA	Sc	Un-known	114 (measured)	Fresh	2	Upper jaw broken.
29.12.2007	29.12.2007	Torre Canne, Fa-sano	40°50′48"	17°27′29"	Stranded (sand)	V	Unknown	Un-known	130 (esti-mated)	Decom-posed	Not re-corded	
4.1.2008	4.1.2008	Punta Penne, Brin-disi	40°40′59"	17°56′06"	Stranded (rocks)	PPdA	SmallDelph (Sc?)	Un-known	196 (measured)	Decom-posed	4	
13.1.2008	13.1.2008	Bocche di Puglia, Brin-disi	40°39′44"	17°58′04"	Stranded (rocks)	PPdA	Sc	Un-known	Unknown	Decom-posed	4	
16.1.2008	16.1.2008	Apani, Brin-disi	40°41′24"	17°50′41"	Stranded (sand)	PPdA	Tt	F	204 (measured)	Decom-posed	4	
18.2.2008	18.2.2008	Torre Guaceto, Carovigno	40°42′57"	17°47′33"	Stranded (sand)	PPdA	Sc	F	196 (measured)	Fresh	2	
20.2.2008	21.2.2008	Punta Penna Grossa, Carovigno	40°43′10"	17°46′38"	Stranded (sand)	PPdA	Sc	M	114 (measured)	Decom-posed	2	Broken rostrum and severe head lesions.
4.3.2008	5.3.2008	Campo di Mare, San Pietro Ver-notico	40°32′54"	18°03′20"	Stranded (sand)	PPdA	Tt	Un-known	167 (measured)	Decom-posed	4	
14.4.2008	14.4.2008	Santa Sa-bina, Carovigno	40°45′28"	17°42′15"	Drifting near shore	PPdA	Tt	M	199 (measured)	Fresh	2	Four deep knife cuts in the chin.
12.5.2008	12.5.2008	Punta della Contessa, Brindisi	40°37′09"	18°01′14"	Stranded (sand)	PPdA	Sc	Un-known	205 (measured)	Decom-posed	4	

ACKNOWLEDGEMENTS

We are grateful to the local authorities involved in this study: Capitaneria di Porto of Brindisi; Comando Provinciale dei Vigili del Fuoco of Brindisi and their Nucleo Sommozzatori; Polizia Municipale of the Brindisi Province's coastal Municipalities; Comando Provinciale dei Carabinieri of Brindisi; Polizia di Stato and its Squadra Nautica; Marina Militare Italiana; Protezione Civile; Provincia di Brindisi. Thanks to Giacomo Baccaro and everybody at the Consorzio Area Marina Protetta of Torre Guaceto for reporting several stranding events. Thanks to the Servizio Veterinario of the Brindisi Local Sanitary Unit (ASL BR01) and to Prof. Nicola Zizzo, Department of Pathological Anatomy, Faculty of Veterinary Medicine, University of Bari. Thanks to all the private individuals who kindly reported the strandings and to all those who helped during the inspections. We are grateful to Stefano Agazzi for his unconditional availability to help and to Giuseppe Notarbartolo di Sciara for contributing relevant literature and useful comments. We are also grateful to Tilen Genov and Lovrenc Lipej for their constructive comments and edits. Finally, the first author is grateful to her daughter Sveva for her patience and for being such an excellent collaborator during inspections of stranded animals.

PREGLED KITOV, NASEDLIH NA OBREŽJU PROVINCE BRINDISI (ITALIJA, JUŽNO JADRANSKO MORJE)

Paola PINO D'ASTORE
I-72100 Brindisi, Via del Lavoro 21B, Italy
E-mail: astorepaola@virgilio.it

Giovanni BEARZI & Silvia BONIZZONI
Tethys Research Institute, I-20121 Milano, Viale G.B. Gadio 2, Italy

POVZETEK

O favni kitov, ki naseljujejo južno Jadransko morje, vemo razmeroma malo. Nasedli kiti so zatorej pomemben vir informacij, ki nam omogočajo vpogled v vrste kitov, ki naseljujejo te vode. Med januarjem 2002 in majem 2008 je bilo zabeleženih 46 primerov, ko so na kakih 100 km jugovzhodnega obrežja Apulije v italijanski provinci Brindisi nasedle različne vrste kitov. Vselej je nasedel po en sam osebek, seznam nasedlih živali pa je naslednji: 2 cuvierjeva kljunata kita Ziphius cavirostris*, 16 velikih pliskavk* Tursiops truncatus*, 9 progastih delfinov* Stenella coeruleoalba*, 4 male pliskavke Delphinidae (po vsej verjetnosti* S. coeruleoalba*), 11 male pliskavke Delphinidae in 4 neznane vrste kitov. Ti podatki dopolnjujejo informacije, ki jih je od leta 1986 zbral italijanski center za študije kitov, in potrjujejo, da so velike pliskavke in progasti delfini tiste vrste, ki jih največkrat najdemo nasedle v provinci Brindisi. Dve najdbi cuvierjevega kljunatega kita sta novi za ta del apulijskega obrežja. Prvi, ki mu je zadnji del telesa bržkone odrezal ladijski vijak, je bil najden 22. februarja 2003, drugi pa je nasedel 6. julija 2003. Dejstvo, da nimamo potrjenih podatkov o navadni pliskavki* Delphinus delphis*, pa potrjujejo domnevo, da je ta vrsta danes redka ali pa je sploh ni v tem delu Sredozemskega morja.*

Ključne besede: nasedli kiti, južno Jadransko morje, Brindisi, Italija

REFERENCES

Aguilar, A. (2000): Population Biology, Conservation Threats and Status of Mediterranean Striped Dolphins (*Stenella coeruleoalba*). J. Cetacean Res. Manage., 2(1), 17–26.

Aguilar, A. & J. A. Raga (1993): The Striped Dolphin Epizootic in the Mediterranean Sea. Ambio, 22(8), 524–528.

Angelici, F. M. & L. Marini (1992): Sighting of *Delphinus delphis* (Cetacea, Odontoceti) in the Otranto Channel (Southern Adriatic Sea and Northern Ionian sea). Hystrix, 4(1), 91–93.

Anonymous (1989): Spiaggiamento di Cetacei lungo le Coste Pugliesi (1987–88). Relazione Preliminare su 12 Soggetti. Regione Puglia, Assessorato all'Ambiente, Settore Ecologia. Levante Editori, Bari.

Bearzi, G., R. R. Reeves, G. Notarbartolo di Sciara, E. Politi, A. Ca adas, A. Frantzis & B. Mussi (2003): Ecology, Status and Conservation of Short-beaked Common Dolphins *(Delphinus delphis)* in the Mediterranean Sea. Mamm. Rev., 33(3), 224–252.

Bearzi, G., D. Holcer & G. Notarbartolo di Sciara (2004): The Role of Historical Dolphin Takes and Habitat Degradation in Shaping the Present Status of Northern Adriatic Cetaceans. Aquatic Conservation: Mar. Freshw. Ecosys., 14, 363–379.

Bearzi, G., S. Agazzi, J. Gonzalvo, M. Costa, S. Bonizzoni, E. Politi, C. Piroddi, R. R. Reeves (2008): Overfishing and the Disappearance of Short-Beaked Common Dolphins from Western Greece. Endangered Species Res., 5, 1–12.

Bearzi, G., C. M. Fortuna & R. R. Reeves *(in press):* Ecology and Conservation of Common Bottlenose Dolphins *Tursiops truncatus* in the Mediterranean Sea. Mamm. Rev.

Bello, G. (1990): I Cetacei dei Mari di Puglia. Umanesimo della Pietra-Verde, 5. Martina Franca, pp. 5–16.

Bortolotto, A., L. Casini & L. A. Stanzani (1992): Dolphins Mortality along the Southern Italian Coast (June-September 1991). Aquat. Mamm., 18(2), 56–60.

Cardellicchio, N., S. Giandomenico, P. Ragone & A. Di Leo (2000): Tissue Distribution of Metals in Striped Dolphins *(Stenella coeruleoalba)* from the Apulian Coasts, Southern Italy. Mar. Environ. Res., 49, 55–66.

Centro Studi Cetacei (1987): Cetacei Spiaggiati Lungo le Coste Italiane. I. Rendiconto 1986. Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 128(3–4), 305–313.

Centro Studi Cetacei (1988): Cetacei Spiaggiati Lungo le Coste Italiane. II. Rendiconto 1987. Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 129(4), 411–432.

Centro Studi Cetacei (1990): Cetacei Spiaggiati Lungo le Coste Italiane. III. Rendiconto 1988. Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 130(21), 269–287.

Centro Studi Cetacei (1991): Cetacei Spiaggiati Lungo le Coste Italiane. IV. Rendiconto 1989. Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 131(27), 413–432.

Centro Studi Cetacei (1992): Cetacei Spiaggiati Lungo le Coste Italiane. V. Rendiconto 1990. Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 132(25), 337–355.

Centro Studi Cetacei (1994): Cetacei Spiaggiati Lungo le Coste Italiane. VI. Rendiconto 1991. Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 133(19), 261–291.

Centro Studi Cetacei (1995): Cetacei Spiaggiati Lungo le Coste Italiane. VII. Rendiconto 1992. Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 134(2), 285–298.

Centro Studi Cetacei (1996a): Cetacei Spiaggiati Lungo le Coste Italiane. VIII. Rendiconto 1993. Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 135(2), 437–450.

Centro Studi Cetacei (1996b): Cetacei Spiaggiati Lungo le Coste Italiane. IX. Rendiconto 1994. Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 135(2), 451–462.

Centro Studi Cetacei (1997a): Cetacei Spiaggiati Lungo le Coste Italiane. X. Rendiconto 1995. Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 136(2), 205–216.

Centro Studi Cetacei (1997b): Cetacei Spiaggiati Lungo le Coste Italiane. XI. Rendiconto 1996. Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 137(1–2), 135–147.

Centro Studi Cetacei (1998): Cetacei Spiaggiati Lungo le Coste Italiane. XII. Rendiconto 1997. Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 139(2), 213–226.

Centro Studi Cetacei (2000): Cetacei Spiaggiati Lungo le Coste Italiane. XIII. Rendiconto 1998. Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 141(1), 129–143.

Centro Studi Cetacei (2001): Cetacei Spiaggiati Lungo le Coste Italiane. XIV. Rendiconto 1999. Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 141(2), 353–365.

Centro Studi Cetacei (2002): Cetacei Spiaggiati Lungo le Coste Italiane. XV. Rendiconto 2000. Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 142(2), 251–264.

Centro Studi Cetacei (2003): Cetacei Spiaggiati Lungo le Coste Italiane. XVI. Rendiconto 2001. Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 144(1), 151–166.

Centro Studi Cetacei (2004): Cetacei Spiaggiati Lungo le Coste Italiane. XVII. Rendiconto 2002 (Mammalia). Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 145(1), 155–169.

Centro Studi Cetacei Onlus e Museo Civico di Storia Naturale di Milano (2004): Cetacei Spiaggiati Lungo le Coste Italiane. XVIII. Rendiconto 2003 (Mammalia). Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 145(2), 425–437.

Centro Studi Cetacei Onlus e Museo Civico di Storia Naturale di Milano (2006a): Cetacei Spiaggiati Lungo le Coste Italiane. XIX. Rendiconto 2004 (Mammalia). Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 147(1), 145–157.

Centro Studi Cetacei Onlus e Museo Civico di Storia Naturale di Milano (2006b): Cetacei Spiaggiati Lungo le Coste Italiane. XX. Rendiconto 2005 (Mammalia). Atti Soc. Ital. Sci. nat. e Mus. Civ. Stor. Nat. Milano, 147(2), 325–335.

Decataldo, A., A. Di Leo, S. Giandomenico & N. Cardellicchio (2004): Association of Metals (Mercury, Cadmium and Zinc) with Metallothionein-like Proteins in Storage Organs of Stranded Dolphins from the Mediterranean Sea (Southern Italy). J. Environ. Monit., 6(4), 361–367.

Holcer, D., G. Notarbartolo di Sciara, C. M. Fortuna, B. Lazar & V. Onofri (2006): Occurrence of Cuvier's Beaked Whales in the Southern Adriatic Sea: Evidence of an Important Mediterranean Habitat. J. Mar. Biol. Ass. U. K., 87, 359–372.

http://thayer.dartmouth.edu/adriatic/bathymetry.html

http://www-1.unipv.it/cibra/spiaggiamenti.html

Kuiken, T. (1996): Diagnosis of By-Catch in Cetaceans. Proceed. 2nd European Cetacean Society Workshop on Cetacean Pathology. 2 March 1994, Montpellier, France. Eur. Cetacean Soc. Newsletter, Special Issue 26, 1–43.

Kuiken, T. & M. G. Hartmann (1991): Cetacean Pathology: Dissection Techniques and Tissue Sampling. Eur. Cetacean Soc., Special Issue, 17, 1–39.

Manoukian, S., M. Azzali & L. Giovagnoli (2004): Features of Cetacean Groups Observed in the Adriatic Sea from 1998 to 2000. Eur. Res. Cetacean, 15, 437–441.

Notarbartolo di Sciara, G. & M. Demma (1997): Guida dei Mammiferi Marini del Mediterraneo. 2a edizione. Franco Muzzio Editore, Padova, 264 p.

Notarbartolo di Sciara, G., M. C. Venturino, M. Zanardelli, G. Bearzi, J. F. Borsani & B. Cavalloni (1993): Cetaceans in the Central Mediterranean Sea: Distribution and Sighting Frequencies. Ital. J. Zool., 60, 131–138.

Podestà, M. & A. Bortolotto (2001): Il Progetto Spiaggiamenti del Centro Studi Cetacei: Analisi dei Risultati di 11 Anni di Attività. In: Borri, M., L. Cagnolaro, M. Podestà & T. Renieri (eds.): Atti del Convegno Nazionale sui Cetacei. Natura Atti Soc. Ital. Sci. nat., Atti Mus. Civ. Stor. Nat. Acquario Civ. Milano, 90(2), 145–158.

Podestà, M., A. D'Amico, G. Pavan, A. Drougas, A. Komnenou & N. Portunato (2006): A Review of Cuvier's Beaked Whale Strandings in the Mediterranean Sea. J. Cetacean Res. Manage., 7(3), 251–261.

Reeves, R. R. & G. Notarbartolo di Sciara (2006): The Status and Distribution of Cetaceans in the Black Sea and Mediterranean Sea. IUCN Centre for Mediterranean Cooperation, Malaga, Spain.

Storelli, M. M., N. Zizzo & G. O. Marcotrigiano (1999): Heavy Metals and Methylmercury in Tissues of Risso's Dolphin and Cuvier's Beaked Whale Stranded in Italy (South Adriatic Sea). Bull. Environ. Contam. Toxicol., 63, 703–710.

Troncone, A., G. Marano, G. O. Marcotrigiano, L. Rositani & N. Zizzo (1990): The Stranding of Cetaceans along the Coasts of Puglia: Connections with Fishing. Report of the GFCM-ICCAT Expert Consultation on Evaluation of Stocks of Large Pelagic Fishes in the Mediterranean Area. 21–27 June 1990, Bari, Italy, pp. 278–282.

Original scientific article
Received: 2008-05-29

UDC 656.11:543:502.51(285.3Škocjanski zatok)

THE IMPACT OF ROAD TRAFFIC ON HYDROCARBON CONTENT IN THE SEDIMENTS OF THE ŠKOCJAN WETLAND

Oliver BAJT
Marine Biology Station, National Institute of Biology, SI-6330 Piran, Fornače 41, Slovenia
E-mail: bajt@mbss.org

ABSTRACT

Traffic is a very important source of hydrocarbons in the marine environment. In the present work the hydrocarbon content (polyaromatic and aliphatic) in the sediments of a coastal wetland, influenced by road traffic, are presented. The results of the analyses show higher concentrations of hydrocarbons in sediments from the area close to the highway. Polyaromatic hydrocarbons are primarily of pyrogenic origin, while aliphatic are mostly of petrogenic origin, indicating fresh inputs of these compounds from the road surface. The reduction of this impact should be an important goal in the revitalization of this protected wetland.

Key words: Škocjan wetland, traffic, pollution, aliphatic hydrocarbons, polyaromatic hydrocarbons, sediments

IMPATTO DEL TRAFFICO STRADALE SUL CONTENUTO DI IDROCARBURI IN SEDIMENTI DELLA ZONA UMIDA DI VAL STAGNON

SINTESI

Il traffico è una fonte molto importante di idrocarburi nell'ambiente marino. L'articolo presenta il contenuto di idrocarburi (poliaromatici e alifatici) nei sedimenti della zona umida costiera, sotto l'influenza del traffico stradale. I risultati delle analisi indicano concentrazioni più elevate di idrocarburi nei sedimenti dell'area prossima alla strada maestra. Gli idrocarburi poliaromatici sono principalmente di origine pirogenica, mentre quelli alifatici hanno un'origine petrogenica, il che indica apporti recenti di tali composti dalla superficie della strada. La riduzione di tale impatto dovrebbe essere di primaria importanza nella fase di rivitalizzazone di quest'area protetta.

Parole chiave: Val Stagnon, zona umida, traffico, inquinamento, idrocarburi alifatici, idrocarburi poliaromatici, sedimenti

INTRODUCTION

Hydrocarbons are compounds primarely composed of carbon and hydrogen. They are the major components of crude oil, fuels and lubricants. Polyaromatic hydrocarbons are also formed during the combustion of organic matter. As such they are important pollutants of the natural environment. They can also arise from natural sources (bacteria, plankton...). Different sources of the introduction of these compounds into the natural environment can be enumerated. The most important among them are oil seepage, oil spillage, traffic, urban runoff, waste water and sewage effluent, as well as atmospheric deposition (GESAMP, 1993). Road traffic is an important source of environmental pollution. Pollutants can arise from a variety of sources, including vehicle exhaust emissions (hydrocarbons, heavy metals, NOx, CO, SO_2, PEC...), vehicle lubricating system losses, vehicle fuel system losses, road surface degradation, degradation of automobile tyres, road surface cleaning/de-iceing and load losses from vehicles.

Determination of various sources of the introduction of such compounds into the marine environment as well as the concentrations of these compounds in the natural environment is of crucial importance to adequately assess the state of the environment. This is especially important where extensive industrial activity or traffic might be expected.

Hydrocarbons are hydrophobic compounds. Because of their low solubility in water, hydrocarbons tend to adsorb on organic or inorganic particles in the water column (Means *et al.*, 1980; Guzella & de Paolis, 1994; Quintero & Diaz, 1994). The enriched suspended matter settles to the sediment surface. In the sediment phase hydrocarbons are less subjected to physico-chemical or biological processes and may accumulate to higher levels. In this way sediments are a better substrate for the assessment of the extent of pollution of the marine environment.

The aim of the present work is to assess the impact of road traffic on pollution by hydrocarbons in the protected area of the Škocjan wetland.

MATERIAL AND METHODS

Study area

The Škocjan wetland is the largest brackish wetland in Slovenia (about 122 ha, average depth 0.5 m). It is located on the margin of the city of Koper and surrounded by agricultural land (Fig. 1). Water circulation is very limited because of a very narrow connection to the sea

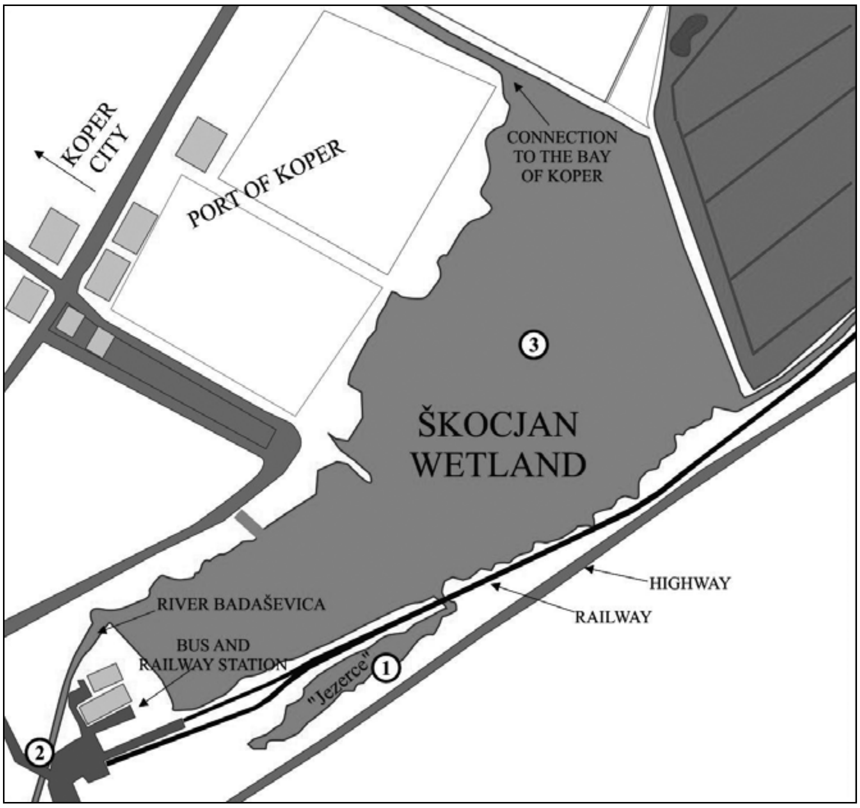


Fig. 1: Location of sampling sites within the investigated area.
Sl. 1: Vzorčevalna mesta na preiskovanem območju.

in the port of Koper. The importance of this lagoon with its surroundings is its rich flora and fauna which boast a number of rare or endangered species. The fate of this area in the past was connected to the industrial development of this area, especially the expansion of the Port of Koper. In the last ten years this area has become a national nature reserve and a special protected area Natura 2000. Many activities were undertaken to re-establish and protect this important wetland.

The wetland receives runoff waters ("Jezerce") from the highway which passes at its south-eastern part. The traffic on this highway is quite intensive, especially in the summer period, when many tourists pass by. The average number of vehicles per day is approaching 45,000 with more than 40,000 cars and around 4,000 trucks. On its southern flank the main bus and railway stations of the city of Koper are located. Runoff waters are introduced into the Badaševica River and consequently into the Škocjan wetland.

For comparison, a reference site (R) was chosen in the Stjuža lagoon in Strunjan. The natural conditions in this lagoon are similar to the investigated wetland (depth, limited circulation, fresh water inflow, sediment composition), with no significant sources of pollution by hydrocarbons (Čermelj *et al.*, 2000).

The sediment in the wetland is grey to dark grey, in some parts even black and with a strong odour of H_2S. It is composed mainly of clayey silt and silty clay, mostly homogeneous in the surficial 10 cm layer. The sediment is characterized by rather high contents of organic C (1–5%) and total N (0.1–0.7%), indicating important eutrophication processes (Čermelj *et al.*, 2000).

Experimental

"For residue analyses" quality hexane, methanol and methylene chloride were used for extraction. All other chemicals were of analytical grade. Extraction thimbles, silica, alumina and sodium sulphate were precleaned with methanol and hexane.

Sediment samples were collected in stainless steel tubes by a scuba diver. Sampling sites are presented in figure 1. The upper 1cm layer of each sediment sample was taken for analysis.

After freeze-drying, the samples were extracted in a Soxhlet apparatus with hexane and methylene chloride (50:50) for 8 hours. The solutions were dried with Na_2SO_4, concentrated in a rotary evaporator and additionally under an N_2 stream. After sulphur removal with activated Cu and additional concentration, the partition of hydrocarbons was performed using column chromatography (Silica, Alumina). Concentrated extracts were analyzed using an HP 5890 gas chromatograph equipped with an FI detector and an HP 3396 integrator. The HP Ultra 2 column (25 m x 0.32 mm, 0.17 μm film thickness) was used for analyses. Quantitative determinations were achieved using both internal and external standards. The analytical procedure is described in detail in UNEP reference methods (UNEP/IOC/IAEA, 1992).

RESULTS AND DISCUSSION

Concentrations of aliphatic hydrocarbons are presented in Table 1. Very high concentrations were observed at station 1, which is close to the highway and receives runoff water from the highway. The concentrations were also higher at station 2, which is situated close to the Koper bus station. Concentrations of hydrocarbons in the middle of the wetland were very low. These concentrations were even lower when compared to the reference site R.

Tab. 1: Content of aliphatic hydrocarbons in sediment samples (ng/g dry sediment).
Tab. 1: Vsebnost alifatskih ogljikovodikov v vzorcih sedimenta (ng/g suhega sedimenta).

Aliphatic hydrocarbons	1	2	3	R
C-17	427	29	2	82
Pristane	85	87	<1	<1
C-18	270	147	<1	<1
Phytane	69	144	<1	<1
C-14 do C-34	41750	1876	44	464
Total aliphatic hydrocarbons	**42807**	**2283**	**46**	**546**

There are different parameters used for the determination of the origin of aliphatic hydrocarbons. The most frequently used parameter is the ratio between the "unresolved complex mixture – UCM" and resolved aliphatic hydrocarbons (Gogou *et al.*, 2000; Commendatore & Esteves, 2004). The UCM is usually considered as a mixture of degraded compounds from oil in the natural environment. It is determined as a background signal in the GC chromatogram. Higher values of this ratio (>10) are indicative of chronic/degraded contamination (Tolosa *et al.*, 2005). The calculated ratios presented in Table 2 reveal significant fresh contamination with hydrocarbons at sampling site 1. The ratio at sampling site 2 shows a prevailing degraded fraction of aliphatic hydrocarbons, but even this does not mean that this area is not affected with fresh inputs in lower amounts. The obtained very high UCM/resolved ratio for the central part of the wetland is an indication of a much degraded area.

The second parameter usually used is the "carbon preference index-CPI" which is a ratio between the contents of aliphatic hydrocarbons with an even number of carbon atoms and those with an odd number of carbon atoms in the range C-27 to C-30. Petrogenic hydrocarbons show values around 1, while those of vascular plants and uncontaminated sediments range from 3 to 6 (Wakeham, 1996; Gogou *et al.*, 2000; Wang *et al.*, 2007).

Tab. 2: Values of parameters used for the determination of the origin of aliphatic hydrocarbons.
Tab. 2: Vrednosti parametrov za določanje izvora alifatskih ogljikovodikov.

Parameter	1	2	3	R
CPI	1.3	2.3	2.5	3.8
UCM/Resolved	8	68	203	12

The CPI at site 1 is close to 1. This is an indication of fresh input of petroleum hydrocarbons. At all other sites the CPI is higher than 2, confirming the more degraded mixture of hydrocarbons or an important source of natural aliphatic hydrocarbons of terrestrial origin in the Badaševica River mouth. This different distribution pattern is also presented in figure 2, showing the typical distribution of aliphatic hydrocarbons in the higher fraction for fresh input (chromatogram A) and that for degraded petroleum hydrocarbons and/or hydrocarbons of terrestrial origin.

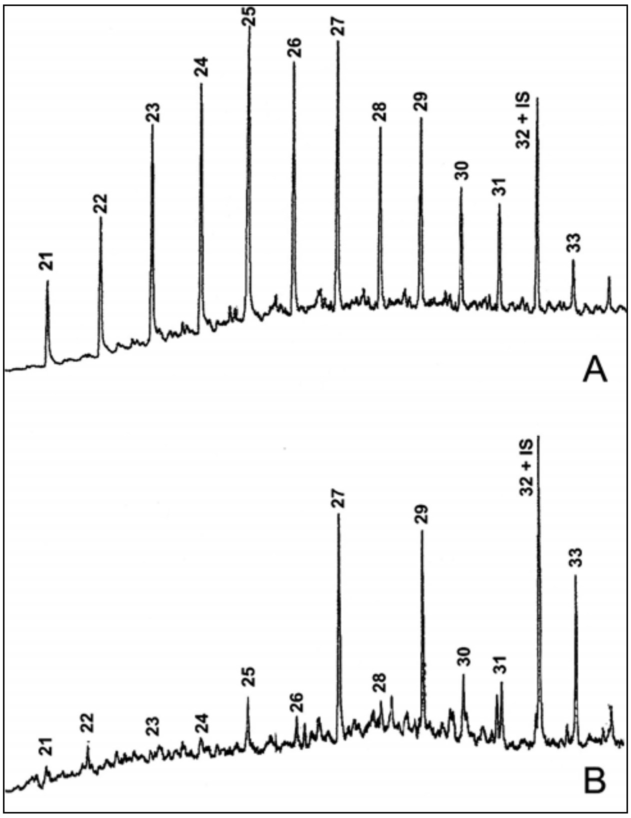


Fig. 2: The chromatograms of the aliphatic hydrocarbon fraction at the sites 1 (A) and 2 (B).
Sl. 2: Kromatograma frakcije alifatskih ogljikovodikov na mestih 1 (A) in 2 (B).

A similar pattern of distribution, but with less significant differences, was also obtained in the case of polyaromatic hydrocarbons (Tab. 3). Their concentrations were about two times higher at sampling site 1 in comparison to sampling site 2. Concentrations of all the determined polyaromatic hydrocarbons at station 3 were below the detection limit of the analytical procedure. The content of these compounds at the reference site was rather low. Concentrations of polyaromatic hydrocarbons, as well as aliphatic hydrocarbons, are in good correlation with the amount of organic C in the sediment samples. The highest content of organic carbon was determined at sampling site 1 (5.13%), it decreased to 3.80% at sampling site 2 and further to 1.11% at site 3 (Čermelj *et al.*, 2000). This correlation indicates rather important interactions of hydrocarbons with organic matter in sediment samples.

The most abundant polyaromatic hydrocarbons are phenanthrene, 1-methylphenanthrene, anthracene, fluoranthene, pyrene, chrysene and benzo[b]fluoranthene. The concentartions of polyaromatic hydrocarbons presented in Table 3 show the prevalence of highly condensed or high molecular weight hydrocarbons (HMW) compared to low molecular weight hydrocarbons (LMW). The calculated ratio (LMW/HMW) is shown in Table 4. For both sites (1 and 2) the ratio is below 1, indicating higher amounts of 4, 5 and 6-ring polyaromatic hydrocarbons. This is characteristic for a pyrogenic (burning of fossil fuels) source of these compounds (Sporstol *et al.*, 1983; Culotta *et al.*, 2006).

This source is also confirmed by a high fluoranthene/pyrene ratio and a low phenanthrene/anthracene ratio. The first ratio (Fl/Py) is usually higher than 1 for polyaromatic hydrocarbons derived from combustion processes, while the Ph/An ratio is significantly lower than 30 for pyrogenic derived hydrocarbons (de Luca *et al.*, 2005; Culotta *et al.*, 2006).

The third ratio presented in Table 4 (Me-Phe/Phe) also reveals the contribution of a petrogenic source of polyaromatic hydrocarbons (Zakaria *et al.*, 2002; Yim *et al.*, 2007). Alkylated compounds are more abundant in crude oil, while the parent compounds are derived during combustion processes. Ratios higher than 2 are significant for a petrogenic source of polyaromatic hydrocarbons.

The above results show that the Škocjan wetland is, in general, only moderately polluted with hydrocarbons. It is usually difficult to distinguish different pollution sources. In the presented case some influence of atmospheric deposition, urban runoff and maritime traffic could contribute to the pollution by hydrocarbons (city of Koper, port of Koper). This contribution is rather small in comparison to that of the road traffic. This is evident

Tab. 3: Concentrations of polyaromatic hydrocarbons in sediment samples.
Tab. 3: Koncentracije poliaromatskih ogljikovodikov v vzorcih sedimenta.

Polyaromatic hydrocarbons	**1**	**2**	**3**	**R**
Naphthalene	18	9	<1	3
1-mehylnaphthalene	<1	<1	<1	<1
1-ethylnaphthalene	<1	<1	<1	<1
Acenaphthene	18	<1	<1	2
Acenaphthylene	<1	<1	<1	<1
2,3,6-trimethylnaphthalene	<1	<1	<1	<1
Phenanthrene	55	37	<1	15
Anthracene	42	19	<1	<1
Fluorene	29	<1	<1	<1
2-methylphenanthrene	61	6	<1	<1
1-methylphenanthrene	172	115	<2	<2
Fluoranthene	122	188	<1	<1
Pyrene	84	54	<1	<1
3,6-dimethylphenanthrene	<2	<2	<2	<2
Perylene	9	5	<1	<1
1-methylpyrene	<1	<1	<1	<1
Chrysene	155	50	<1	<1
Benzo[k]fluoranthene	55	13	<1	<1
Benzo[b]fluoranthene	123	29	<1	<1
Benzo[e]pyrene	3	6	<1	<1
Benzo[a]pyrene	39	8	<1	<1
Benzo[a]anthracene	41	34	<1	<1
Total polyaromatic hydrocarbons	**1026**	**573**		**20**

from the elevated concentrations of hydrocarbons in the area affected by road runoff. Comparison of hydrocarbon content in sediments from these areas of the Škocjan wetland with other parts of the Slovenian sea, even the port of Koper, shows concentrations of a few times higher (Bajt, 2000; Notar *et al.*, 2001). These observations certainly show the important impact of road traffic on pollution of the wetland, but for a better assessment of its extent some additional study should be undertaken, including the transformation and sink of hydrocarbons in such a specific environment.

Tab. 4: Values of parameters used for the determination of the origin of polyaromatic hydrocarbons.
Tab. 4: Vrednosti parametrov za določanje izvora poliaromatskih ogljikovodikov.

Parameter	**1**	**2**
LMW (ng/g)	395	186
HMW (ng/g)	631	387
LMW/HMW	0.63	0.48
Me-Phenanthrenes/Phenanthrene	4.24	3.27
Fluoranthene/Pyrene	1.45	2.90
Phenanthrene/Anthracene	1.31	1.95

CONCLUSIONS

Results of the present study show the significant impact of road traffic on the Škocjan wetland, a protected area, in terms of hydrocarbons content in sediments. Higher concentrations were found in the "Jezerce" part, which directly receives runoff water from the highway. The area near the bus and railway station is less polluted. The central part of wetland is a much degraded area. Concentrations of hydrocarbons are low, even compared with concentrations at the reference site. These low concentrations are probably due to intensive microbial and photochemical degradation, as well as bioaccumulation in rich vegetation. Aliphatic hydrocarbons are mostly of petrogenic origin (fuels) with some contribution from terrestrial derived compounds (freshwater inputs). The origin of polyaromatic hydrocarbons is mostly pyrogenic (combustion of fuels), with even some petrogenic origin evident. The obtained concentrations of hydrocarbons at sites 1 and 2 are rather high and could be connected to traffic pollution. The reduction of this impact should be an important goal in the revitalization of this protected wetland.

VPLIV CESTNEGA PROMETA NA VSEBNOST OGLJIKOVODIKOV V ŠKOCJANSKEM ZATOKU

Oliver BAJT

Morska biološka postaja, Nacionalni inštitut za biologijo, SI-6330 Piran, Fornače 41, Slovenija

E-mail: bajt@mbss.org

POVZETEK

Promet je pomemben vir onesnaževanja morskega okolja z ogljikovodiki. V pričujočem delu so predstavljene vsebnosti ogljikovodikov (alifatskih in poliaromatskih) v sedimentu obalnega mokrišča, ki je pod vplivom cestnega prometa. Rezultati analiz kažejo povišane koncentracije ogljikovodikov v sedimentu na področju v bližini avtoceste. Poliaromatski ogljikovodiki so večinoma pirogenega izvora, alifatski ogljikovodiki pa so večinoma petrogenega izvora, kar kaže na sveže onesnaževanje s ceste. Zmanjšanje vpliva cestnega prometa na onesnaževanje Škocjanskega zatoka bi moralo biti med prednostnimi nalogami njegove revitalizacije.

Ključne besede: Škocjanski zatok, promet, onesnaževanje, alifatski ogljikovodiki, poliaromatski ogljikovodiki, sedimenti

REFERENCES

Bajt, O. (2000): Hydrocarbons in sea water and sediments of the Slovenian part of the Gulf of Trieste. Annales, Ser. Hist. Nat., 10(1), 61–66.

Commendatore, M. G. & J. L. Esteves (2004): Natural and anthropogenic hydrocarbons in sediments from the Chubut river (Patagonia, Argentina). Mar. Pollut. Bull., 48, 910–918.

Culotta, L., C. de Stefano, A. Gianguzza, M. R. Mannini & S. Orecchio (2006): The PAH composition of surface sediments from Stagnone coastal lagoon, Marsala (Italy). Mar. Chem., 99, 117–127.

Čermelj, B., P. Mozetič, O. Bajt, V. Turk, B. Vrišer, N. Kovač, L. Lipej & A. Vukovič (2000): Raziskave in monitoring Škocjanskega zatoka – pregled stanja kakovosti vode in sedimenta v vodni laguni znotraj rezervata in kakovosti reke Badaševice. Nacionalni inštitut za biologijo, Morska biološka postaja, Piran, 71 str.

GESAMP (1993): Reports and studies No. 50. IMO, London.

Gogou, A., I. Bouloubassi & E. G. Stephanou (2000): Marine organic geochemistry of the Eastern Mediterranean. 1. Aliphatic and polyaromatic hydrocarbons in Cretan Sea surficial sediments. Mar. Chem., 68, 265–282.

Guzzella, L. & A. de Paolis (1994): Polycyclic aromatic hydrocarbons in sediments of the Adriatic Sea. Mar. Pollut. Bull., 28, 159–165.

de Luca, G., A. Furesi, G. Micera, A. Panzanelli, P. C. Piu, M. I. Pilo, N. Spano & G. Sanna (2005): Nature, distribution and origin of polycyclic aromatic hydrocarbons (PAHs) in the sediments of Olbia harbor (Northern Sardinia, Italy). Mar. Pollut. Bull., 50, 1223–1232.

Means, J. C., S. G. Wood, J. J. Hassett & W. L. Banwart (1980): Sorption of PAH by sediments and soils. Environ. Sci. Technol., 14, 1524–1528.

Notar, M., H. Leskovsek & J. Faganeli (2001): Composition, distribution and sources of polycyclic aromatic hydrocarbons in sediments of the Gulf of Trieste, northern Adriatic Sea. Mar. Pollut. Bull., 42, 36–44.

Quintero, S. & C. Diaz (1994): Aliphatic hydrocarbons in fish from the Canary Islands. Mar. Pollut. Bull., 28, 44–49.

Sporstol, S., N. Gjos, R. G. Lichtenthaler, K. O. Gustavsen, K. Urdal, F. Oreld & J. Skel (1983): Source identification of aromatic hydrocarbons in sediments using GC/MS. Environ. Sci. Technol., 17, 282–286.

Tolosa, I., S. J. de Mora, S. W. Fowler, J.-P. Villeneuve, J. Bartocci & C. Cattini (2005): Aliphatic and aromatic hydrocarbons in marine biota and coastal sediments from the Gulf and the Gulf of Oman. Mar. Pollut. Bull., 50, 1619–1633.

UNEP/IOC/IAEA (1992): Determination of petroleum hydrocarbons in sediments. Reference methods for marine pollution studies, No. 20. UNEP.

Wakeham, S. G. (1996): Aliphatic and polycyclic aromatic hydrocarbons in Black sea sediments. Mar. Chem., 53, 187–205.

Wang, L., F. S. C. Lee & X. Wang (2007): Chemical characteristics and source implications of petroleum hydrocarbon contaminants in the sediments near major drainage outfalls along the coastal of Laizhou bay, Bohai Sea, China. Environ. Monit. Assess., 125, 229–237.

Yim, U. H., S. H. Hon & W. J. Shim (2007): Distribution and characteristics of PAHs in sediments from the marine environment of Korea. Chemosphere, 68, 85–92.

Zakaria, M. P., H. Takada, S. Tsutsumi, K. Ohno, J. Yamada, E. Kouno & H. Kumata (2002): Distribution of polycyclic aromatic hydrocarbons (PAHs) in rivers and estuaries in Malaysia: A widespread input of petrogenic PAHs. Environ. Sci. Technol., 36, 1907–1918.

Saggio scientifico originale
Ricevuto: 2008-04-18

UDC 502:574.5(262.26)

UTILIZZO DI SISTEMI DI VALUTAZIONE DELLA QUALITA' COSTIERA DELLA CIRENAICA (JAMAHIRIYA LIBYA – MEDITERRANEO SUD ORIENTALE) MEDIANTE INDICATORI DERIVATI DALL'ECOLOGIA DEL PAESAGGIO

Saul CIRIACO, Claudio FRANCI, Carlo FRANZOSINI, Erik MERSON & Roberto ODORICO
SHORELINE soc. coop. – CeRQuAM (Centro di Ricerca per la Qualità dell'Ambiente Marino), Area Science Park,
I-34012 Trieste, Padriciano 99, Italia
E-mail: shoreline@shoreline.it

SINTESI

L'utilizzo di indicatori relativi alle condizioni ambientali ed alle attività dell'uomo è stato applicato in Cirenaica (Libia), un'area in cui le informazioni sulle caratteristiche biologiche sono estremamente scarse e dove normali sistemi di monitoraggio (immersioni subacquee) si scontrano con le necessità logistiche ed i tempi autorizzativi. La ricerca ha un valore preliminare, ma risponde allo scopo di costruire uno scenario di sintesi per permettere alle autorità locali una prima valutazione dell'ambiente costiero per poi procedere alle ulteriori fasi di approfondimento. L'approccio utilizzato si richiama all'ecologia del paesaggio ed è stato precedentemente utilizzato in campagne di studio per la pianificazione costiera nell'Alto Adriatico. La valutazione rapida dell'ambiente da la possibilità di replicare ed implementare le informazioni. L'indagine ha portato ad una differenziazione della costa tra aree di pregio ambientale ed aree antropizzate.

Parole chiave: ecologia del paesaggio, valutazione rapida dell'ambiente marino-costiero, costa mediterranea, Libia, Cirenaica

UTILIZATION OF EVALUATION SYSTEMS CONCERNING COASTAL QUALITY OF CYRENAICA (JAMAHIRIYA LIBYA – SOUTH EASTERN MEDITERRANEAN SEA) THROUGH LANDSCAPE ECOLOGY INDICATORS

ABSTRACT

The utilization of indicators related to the environmental conditions and human activities has been experimented in Cyrenaica (Libya), in an area where the information on biological features is indeed scarce and the normal monitoring systems (SCUBA diving) clash with logistic necessities and authorization times. The research has a preliminary value, but it is aimed at making a synthesis that will give to the local authorities a first evaluation of the coastal environment and the possibility to deepen the study. The approach, the so-called landscape ecology, had been previously used in studies for the Northern Adriatic coastal planning. A quick evaluation of the environment renders us a possibility to reply and implement the information. The research has led to a differentiation of the coast in good environmental quality areas and areas under high human influences.

Key words: landscape ecology, rapid marine coastal assessment, Mediterranean coast, Libya, Cyrenaica

INTRODUZIONE

La regione mediterranea è stata identificata dal WWF come una delle regioni marine più importanti nel mondo per le caratteristiche eccezionale di biodiversità e per questo motivo la sua conservazione è di fondamentale importanza (WWF – "Global 200" è un'iniziativa che ha individuato 238 ecoregioni nelle quali sarebbe ospitata un'elvata diversità di specie animali e vegetali (http://www.worldwildlife.org/science/ecoregions/global200.html)). Inoltre la regione è sottoposta ad un livello molto elevato di pressione umana e quindi deve essere protetta con estrema urgenza. Il progetto "Gap Analysis marina del Mediterraneo" (Franzosini *et al.*, 2001) aveva analizzato le zone con un livello potenzialmente elevato di biodiversità e, contestualmente, la presenza delle minacce importanti derivanti dall'attività umana. Furono identificate in totale 13 zone costiere, che necessitano urgentemente di tutela ambientale e di una gestione migliorata. La costa della Cirenaica è una di queste 13 zone costiere.

L'obiettivo di questa indagine è stato di compiere una valutazione preliminare delle emergenze ambientali litoranee e marine della costa della Cirenaica (Libia), verificandone pure le condizioni di conservazione. I risultati dovrebbero permettere di sviluppare un modello di conservazione ambientale per la zona in esame. La zona di studio è l'ambiente litoraneo e marino dell'area compresa tra Tulmaythah a Ra's At Tin, ad est di Darnah.

L'indagine è stata condotta per conto e con il contributo economico del WWF – Mediterranean Programme Office (Roma).

Rassegna dei lavori relativi gia' pubblicati

Lo studio del territorio e delle configurazioni spaziali che gli ecosistemi assumono nel territorio viene definito "ecologia del paesaggio". Questa scienza si inserisce quindi come la disciplina che studia le aggregazioni di ecosistemi (sistemi di ecosistemi): questi costituiscono il paesaggio, entità che assume caratteristiche diverse dalla somma delle caratteristiche degli ecosistemi che lo compongono. Infatti il paesaggio è considerato come la risultante di tutti i processi (sia antropici che naturali) che avvengono in un mosaico complesso di ecosistemi (Romanini, 1994).

La capacità dell'ecologia del paesaggio di studiare in un solo momento il paesaggio antropico e quello naturale come parti di un unico sistema diversificato, permette un approccio ai problemi territoriali in grado di superare la tradizionale conflittualità che vede le istanze antropiche in opposizione alle esigenze dei sistemi naturali; ciò offre l'opportunità di soluzioni integrate a volte innovative. Vengono ad affiancarsi più discipline al fine di proteggere la sostenibilità degli ecosistemi nel paesaggio (Finke, 1993).

E' peraltro comune a tutte le discipline coinvolte nel campo dell'ecologia del paesaggio una procedura che inizia dalla semplice osservazione, per giungere ad una rilevazione e ad una quantificazione scientifico-analitica, la quale rappresenta sempre più spesso la base per una modellistica matematica.

L'approccio utilizzato in questo studio si richiama all'ecologia del paesaggio, ed è stato precedentemente utilizzato in campagne di studio per la pianificazione costiera nell'Alto Adriatico (Odorico *et al.*, 2001) in cui era importante arrivare rapidamente ad un riconoscimento della struttura di una porzione del territorio mettendone in luce le caratteristiche principali e gli eventuali squilibri. Tale processo necessariamente si avvaleva di dati ed informazioni multidisciplinari che se analizzati globalmente, andavano organizzati in una serie di semplici descrittori per giungere ad un dato di qualità facilmente comprensibile da chi amministra il territorio.

Successivamente è stato impiegato, per il golfo di Trieste, nelle tesi di laurea in ecologia applicata da parte di E. Merson (2002) e B. Merson (2003). Ulteriori applicazioni hanno permesso una lettura di più ampie zone del bacino del Mediterraneo mediante tecnologie GIS (Franzosini *et al.*, 2001). La valutazione rapida della qualità dell'ambiente marino-costiero fornisce la possibilità di strutturare ed implementare le informazioni disponibili e quelle acquisite sul campo, per poi trasmetterle alle amministrazioni locali in vista dei successivi approfondimenti necessari alla pianificazione territoriale; è quindi intesa quale strumento di indagine preliminare utile alla Gestione Integrata della Fascia Costiera (Integrated Coastal Zone Management).

Tale tipo di indagine porta ad una differenziazione della costa in termini di aree ad elevata qualità ambientale evidenziando le maggiori vulnerabilità che sono da portate a conoscenza delle amministrazioni interessate alla pianificazione territoriale.

MATERIALI E METODOLOGIA

L'utilizzo di indicatori relativi alle condizioni ambientali ed alle attività dell'uomo è stato sperimentato in Cirenaica, un'area mediterranea del litorale libico in cui le informazioni inerenti le caratteristiche biologiche risultavano estremamente scarse e dove normali sistemi di monitoraggio effettuati in immersione subacquea con autorespiratore, legati a prelievi e determinazioni dei campioni da portare in Italia, si scontravano con le reali disponibilità logistiche ed i tempi autorizzativi. Pur considerando il valore eminentemente preliminare della ricerca, era indispensabile costruire uno scenario di sintesi per permettere una prima valutazione delle peculiarità ambientali presenti lungo la costa e le relative minacce, per poi procedere alle ulteriori fasi di approfondimento.

La squadra di lavoro, composta da 5 tecnici della società Shoreline con il supporto di altrettanti colleghi del Laboratorio Nazionale di Biologia Marina libico, del

personale e dei mezzi della guardia costiera libica e dell'EGA (Environmental General Authority), ha eseguito il monitoraggio ambientale nel corso delle prima metà del mese di giugno 2004 (02/06/04 – 16/06/ 04).

Questa indagine è stata svolta con le seguenti metodologie:

– sopralluoghi in mare per l'osservazione diretta in apnea con nuoto pinnato lungo transetti e per mezzo di ROV (Remotely Operated Vehicle), volti alla caratterizzazione del fondale marino per mezzo di indicatori del valore naturalistico,
– descrizione del litorale e degli habitat principali per mezzo di indicatori relativi alle condizioni ambientali ed alle attività umane.

Per l'analisi delle componenti marine, sono state effettuate una serie di ricognizioni da mare e da terra per un totale di 66 stazioni di campionamento (le cui posizioni, rilevate con GPS, sono riportate nell' Allegato 1), di cui 5 più profonde (22–50 m) effettuate per mezzo di ROV, distribuite su 15 zone di studio (da A a Q, da Ovest verso Est) in modo tale da coprire nel modo più omogeneo possibile il tratto di costa sotto esame.

Il metodo di analisi applicato, messo a punto in golfo di Trieste a partire dalle indicazioni di Mc Harg (1969) e di Boca & Oneto (1990), prevede le seguenti valutazioni:

Il valore di bioqualità

Alle varie zone di studio viene assegnato un valore relativo alla bioqualità, che deriva dalla somma delle specie di alghe, della ittiofauna e delle altre specie particolari (protette o di importanza locale) rilevate nelle singole stazioni di campionamento che vi appartengono. Hanno contribuito alla determinazione della check-list non solo le osservazioni dirette effettuate durante i campionamenti, ma anche l'analisi delle fotografie scattate durante gli stessi nonché l'integrazione ed il confronto con le check-list fornite dagli enti di ricerca locali. In sede di definizione e segnalazione di specie rare o protette sono state considerate le specie elencate nelle liste ufficiali (es: Natura 2000, Livre Rouge "Gerard Vuigner" 1990; Annessi alla Convenzione di Barcellona; Annessi alla Convenzione di Berna).

Per l'analisi di bioqualità delle componenti marine, il tratto di costa va suddiviso in zone omogenee dal punto di vista delle caratteristiche del supralitorale. Ad ogni zona viene quindi assegnato un valore di bioqualità per le componenti marine attraverso la valutazione di 4 fattori:

1. Tipologia del substrato
   1a) Diversità della tipologia del substrato
2. Fisionomia del popolamento vegetale
   2a) Diversità del popolamento vegetale
3. Grado di copertura di animali sessili
   3a) Diversità della copertura di animali sessili
4. Abbondanza di fauna ittica
   4a) Diversità della fauna ittica

Valutazione della tipologia del substrato

Per la valutazione del fondale si fa riferimento alla fascia compresa tra la linea della battigia e l'interfaccia con i sedimenti fangosi, coincidente grossomodo con il limite batimetrico della vegetazione marina.

Si attribuisce il punteggio a due diverse fasce batimetriche consecutive a partire dal limite di 0 metri, in modo da meglio contemplare i vari sistemi che si possono presentare, in quanto nello spazio di pochi metri la tipologia del fondale può mutare in modo considerevole, sia per quel che riguarda il grado di influenza antropica, sia per le granulometrie, ma anche per la composizione dei materiali naturali.

Ad ogni tipo di substrato corrisponde una diversa potenzialità di colonizzazione, sia vegetale che animale. In particolare i fondali duri, rispetto a quelli incoerenti, sono più idonei all'attecchimento delle specie bentoniche. Non per questo, però, è possibile attribuire una "naturalità" maggiore ai primi rispetto ai secondi. Si preferisce quindi adottare una scala di valori riferiti unicamente alla presenza di modifiche antropiche del substrato rispetto alle condizioni naturali della zona. E' chiaro che un substrato artificiale completamente ricoperto non è da considerarsi un fatto negativo dal punto di vista biologico, ma acquisterà valore al momento di considerare le componenti biotiche.

Ai reperti archeologici e ai relitti è assegnato il punteggio massimo: in questo modo si vuole mettere in risalto i valori storici e suggestivi. Inoltre, nonostante siano di fatto "alterazioni" dell'ambiente naturale, non si può negare che ormai l'elemento sia divenuto, nel tempo, parte integrante dell'ambiente che lo ospita.

Sulla base di queste considerazioni, il punteggio viene attribuito secondo la seguente tabella:

valore	descrizione
1	substrato artificiale di composizione diversa da quella naturale della zona
2	substrato artificiale di composizione uguale a quella della zona
3	substrato misto con composizione della parte artificiale diversa da quella naturale della zona
4	substrato misto con composizione della parte artificiale uguale a quella naturale della zona
5	substrato naturale, reperti archeologici, relitti

Valutazione della fisionomia del popolamento vegetale

Si suddivide l'area in esame in due fasce batimetriche per il tratto in esame (le stesse fasce usate in precedenza). Essendo i popolamenti vegetali strettamente correlati alla tipologia di substrato, si adottata la stessa suddivisione in piani anche nel caso delle caratteristiche

biotiche. Si raggiunge così anche l'obiettivo di aumentare il numero di punteggi assegnati ad una zona, permettendo, in questo modo, una migliore differenziazione tra zone simili. Il punteggio attribuito secondo la seguente tabella:

valore	descrizione
1	colonizzazione nulla
2	alghe incrostanti
3	feltro vegetale (da mosaico a esteso)
4	popolamento stratificato a mosaico, prateria a fanerogame rada
5	popolamento stratificato continuo, prateria a fanerogame integra

Valutazione del grado di copertura di animali sessili

Il punteggio è stato attribuito secondo la seguente tabella, seguendo una classificazione adottata in accordo con la metodologia Zurich-Montpelier (cfr. Pérès & Picard, 1964):

valore	descrizione
1	organismi sparsi, copertura <5%
2	organismi numerosi, copertura tra il 5% e il 25%
3	organismi molto numerosi, copertura tra il 25% e il 50%
4	organismi molto numerosi, copertura tra il 50% e il 75%
5	copertura >75%

Valutazione dell'abbondanza di fauna ittica

La presenza di ittiofauna è riportata sulla base delle comuni procedure di visual census, distinguendo tra individui giovanili ed adulti, senza che questa divisione rispecchi un preciso rigore scientifico. L'informazione che se ne vuole trarre, infatti, è puramente qualitativa. Il valore di abbondanza è attribuita secondo la tabella modificata da Harmelin-Vivien & Francour (1992):

valore	descrizione
1	1 individuo
2	da 2 a 10 individui
3	da 11 a 50 individui
4	da 51 a 500 individui
5	> 500 individui

Il valore di qualità del paesaggio

Per l'assegnazione di questo punteggio si è preso spunto da quella che è stata l'esperienza della Shoreline nel monitoraggio e nel visual census applicati alle acque litoranee della Riserva Marina di Miramare (Odorico *et al.*, 2001).

In particolare, ferme restando le difficoltà di creare un sistema di punteggi che sia il più oggettivo possibile, è stata impiegata una scala di valori secondo lo schema seguente:

valore	descrizione
1	paesaggio subacqueo poco significativo, ambiente degradato, bassissima diversità di specie ed associazioni
2	paesaggio subacqueo con alcune peculiarità significative
3	paesaggio subacqueo abbastanza significativo in cui viene percepita con facilità una discreta diversità di specie ed associazioni
4	paesaggio subacqueo ove sono state osservate specie ed associazioni tipiche, endemiche, vulnerabili
5	paesaggio naturale o seminaturale in cui sono osservabili specie ed associazioni tipiche, endemiche, vulnerabili, in quantità tale da rappresentare esse stesse elemento predominante della zona

Questo fattore, a differenza di quelli precedenti, viene considerato un'unica volta per la singola zona, senza distinzioni a seconda della profondità. Tale scelta è stata fatta sia perché si rischierebbe di dover assegnare il punteggio a zone troppo ristrette, sia per la volontà di non dare un eccessivo peso ad un fattore che, tra tutti, ha una certa connotazione di soggettività.

L'elemento estetico-paesaggistico terrestre viene preso in considerazione attribuendo alla zona in esame un punto supplementare in presenza, ad esempio, di associazioni vegetali contenenti specie con fioriture vistose oppure perché rappresentate da specie vegetali arboree di particolare valore naturalistico.

Il valore di impatto antropico

L'influenza antropica viene valutata visivamente, basandosi sulle osservazioni durante le uscite in mare e gli spostamenti lungo il litorale e sulla lista delle attività antropiche che possono avere un'influenza lungo le zone costiere (cfr. Tyler-Walters *et al.*, 2001). Lo scopo non era, in questa sede, di analizzare in modo approfondito tutti gli effetti che le attività censite potrebbero avere sull'ambiente costiero, bensì di tentare di individuare quei disturbi puntuali, localizzati nell'area in esame al momento del sopralluogo, con effetti che possono essere percepiti visivamente dall'osservatore. Gli impatti riscontrati nel corso delle uscite sono classificati in cinque categorie: per ogni zona viene calcolato il totale. Da questo si risale alla classe di impatto seguendo la stessa logica delle classi di valore di qualità del paesaggio.

valore	descrizione
1	impatto nullo
2	impatto medio-basso
3	impatto medio
4	impatto medio-alto
5	impatto alto

Il calcolo del valore complessivo di qualità

Il valore complessivo per ogni zona individuata all'interno dell'area di studio si ottiene attraverso la media dei valori della bioqualità, del paesaggio e dell'impatto antropico o, se in ambito GIS, dalla sovrapposizione dei rispettivi layer che, inseriti nella mappa finale, consentono una interpretazione del territorio più circostanziata.

In questo modo, infatti, è possibile in ogni momento evidenziare il contributo delle tre componenti ed avere, parallelamente al valore finale, l'evidenza di quale sia (o quali siano) la componente che influenza maggiormente la zona di studio.

RISULTATI

I dati raccolti per ogni fattore sono stati organizzati in una tabella ("Scheda giudizio stazioni") e successivamente trasformati in valori numerici ("Scheda valori stazioni"). Le 15 zone – di seguito elencate da Ovest verso Est – sono quindi state complessivamente valutate come segue:

Zona A: Tulmaythah (stazione di campionamento: 59)

estremo Ovest (long.)	20°56'58,96" E	estremo Est (long.)	20°56'58,96" E
valore di bioqualità	2	valore di impatto antropico	2
valore di qualità del paesaggio	3	**valore complessivo di qualità**	**3**

Zona B: Tulmaythah – Qasi ad Disah (stazioni di campionamento: 39, 40, 49, 50, 51, 52, 53, 54, 55, 56, 57)

estremo Ovest (long.)	20°58'57,20" E	estremo Est (long.)	21°26'20,13" E
valore di bioqualità	4	valore di impatto antropico	4
valore di qualità del paesaggio	4	**valore complessivo di qualità**	**4**

Zona C: Qasi ad Disah – Al Haniya (stazioni di campionamento: 1, 2, 3, 4, 37, 38)

estremo Ovest (long.)	21°28'49,98" E	estremo Est (long.)	21°33'45,92" E
valore di bioqualità	3	valore di impatto antropico	2
valore di qualità del paesaggio	3	**valore complessivo di qualità**	**3**

Zona D: Al Haniya – Ra's Amir (stazioni di campionamento: 5, 6, 7, 10, 45, 46, 47, 48)

estremo Ovest (long.)	21°39'53,88" E	estremo Est (long.)	21°47'9,28" E
valore di bioqualità	2	valore di impatto antropico	4
valore di qualità del paesaggio	2	**valore complessivo di qualità**	**3**

Zona E: Ra's Amir – Susah (stazioni di campionamento: 8, 9, 11, 12)

estremo Ovest (long.)	21°49'55,04" E	estremo Est (long.)	21°56'23,68" E
valore di bioqualità	2	valore di impatto antropico	4
valore di qualità del paesaggio	3	**valore complessivo di qualità**	**3**

Zona F: Susah (stazioni di campionamento: 26, 58, 60)

estremo Ovest (long.)	21°58'1,90" E	estremo Est (long.)	22°0'28,65" E
valore di bioqualità	2	valore di impatto antropico	3
valore di qualità del paesaggio	3	**valore complessivo di qualità**	**3**

Zona G: Susah – Ra's al Hilal (stazioni di campionamento: 13, 22, 25)

estremo Ovest (long.)	22°3'14,11" E	estremo Est (long.)	22°6'4,55" E
valore di bioqualità	2	valore di impatto antropico	3
valore di qualità del paesaggio	2	**valore complessivo di qualità**	**2**

Zona H: Ra's al Hilal (stazioni di campionamento: 23, 24)

estremo Ovest (long.)	22°10'11,44" E	estremo Est (long.)	22°10'20,69" E
valore di bioqualità	3	valore di impatto antropico	5
valore di qualità del paesaggio	3	**valore complessivo di qualità**	**4**

Zona I: Ra's al Hilal – Springs (stazioni di campionamento: 14, 18, 19, 20, 21)

estremo Ovest (long.)	22°10'32,61" E	estremo Est (long.)	22°11'40,40" E
valore di bioqualità	2	valore di impatto antropico	2
valore di qualità del paesaggio	2	**valore complessivo di qualità**	**2**

Zona L: Springs – Ra's bin Jabar (stazioni di campionamento: 15, 16, 61, 62, 63, 64)

estremo Ovest (long.)	22°13'20,60" E	estremo Est (long.)	22°20'32,00" E
valore di bioqualità	2	valore di impatto antropico	3
valore di qualità del paesaggio	3	**valore complessivo di qualità**	**3**

Zona M: Ra's bin Jabar (stazioni di campionamento: 17, 43, 44)

estremo Ovest (long.)	22°22'1,00" E	estremo Est (long.)	22°23'10,24" E
valore di bioqualità	4	valore di impatto antropico	5
valore di qualità del paesaggio	3	**valore complessivo di qualità**	**4**

Zona N: Ra's Karsa – Darnah (stazioni di campionamento: 27, 28, 29, 30)

estremo Ovest (long.)	22°26'7,02" E	estremo Est (long.)	22°31'57,18" E
valore di bioqualità	3	valore di impatto antropico	3
valore di qualità del paesaggio	4	**valore complessivo di qualità**	**3**

Zona O: Darnah (stazioni di campionamento: 41, 42)

estremo Ovest (long.)	22°39'14,55" E	estremo Est (long.)	22°40'49,05" E
valore di bioqualità	2	valore di impatto antropico	2
valore di qualità del paesaggio	2	**valore complessivo di qualità**	**2**

Zona P: Sidi Awn (stazioni di campionamento: 31, 32, 33, 65, 66)

estremo Ovest (long.)	22°40'0,23" E	estremo Est (long.)	22°55'25,66" E
valore di bioqualità	3	valore di impatto antropico	4
valore di qualità del paesaggio	4	**valore complessivo di qualità**	**4**

Zona Q: Wadi el Hamassah – Ra's at Tin (stazioni di campionamento: 34, 35, 36)

estremo Ovest (long.)	23°0'5,10" E	estremo Est (long.)	23°6'6,34" E
valore di bioqualità	4	valore di impatto antropico	4
valore di qualità del paesaggio	3	**valore complessivo di qualità**	**4**

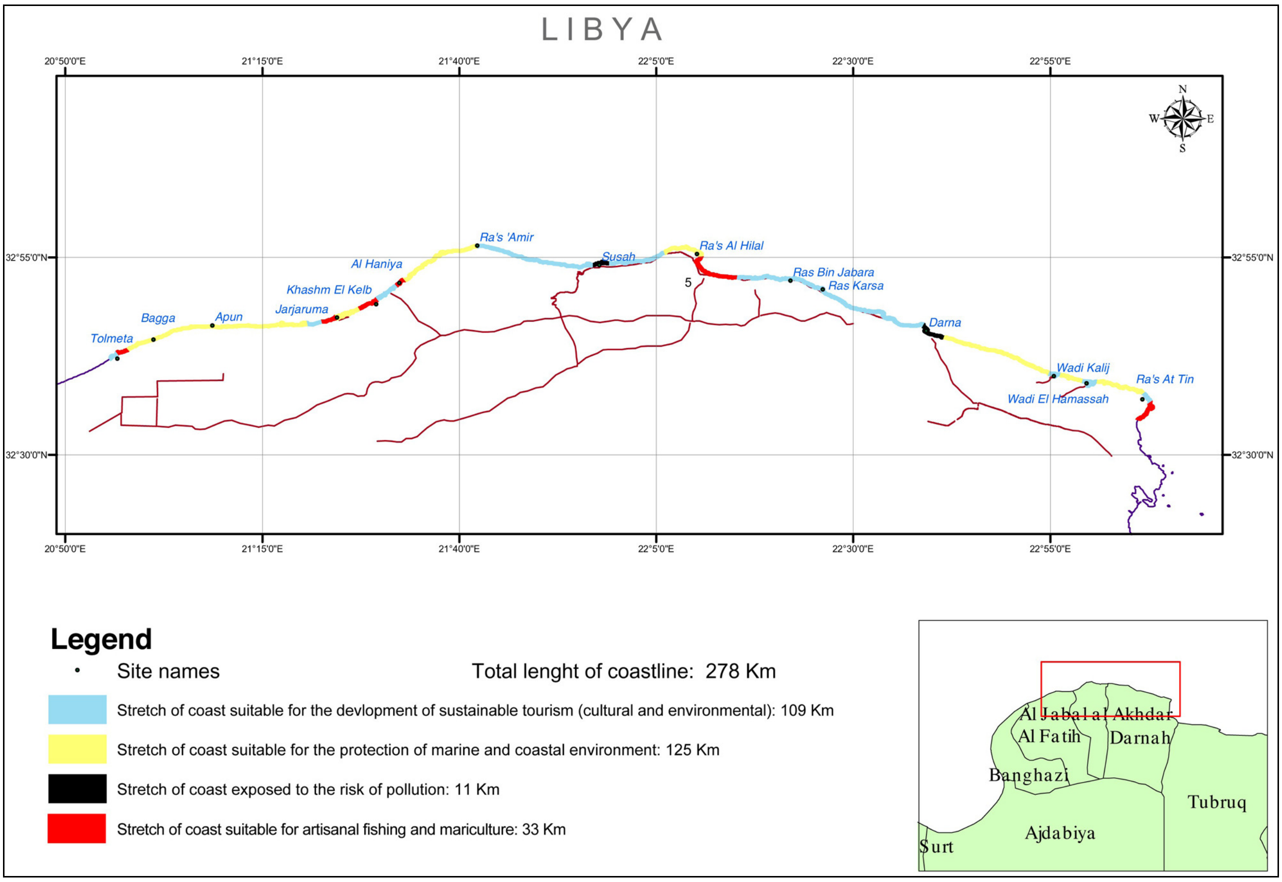


Fig. 1: Area di studio e classificazione dei tratti di costa (278 km totali). Legenda:
Sl. 1: Območje raziskav in klasifikacija delov obale (skupno 278 km). Legenda:
area vocata al turismo naturalistico e culturale (109 km) / območje, namenjeno naturalističnemu in kulturnemu turizmu (109 km)
area vocata alla tutela dell'ambiente marino-costiero (125 km) / območje, namenjeno varovanju morja in obrežja (125 km)
area sottoposta a rischio di impatto ambientale (11 km) / območje, izpostavljeno antropogenemu vplivu (11 km)
area vocata alla pesca artigianale e maricoltua (33 km) / območje, namenjeno manjšemu ribolovu in marikulturi (33 km)

Sono quindi stati prodotti:

- una mappa riportante i segmenti della linea di costa in cui si dovrebbero approfondire da una parte gli studi biologici finalizzati ad azioni di tutela ambientale e dall'altra quelli di idoneità allo sviluppo del turismo sostenibile e di pesca/maricoltura (Fig. 1);
- un'indicazione sugli obiettivi ed attività prioritarie per ridurre i rischi ambientali e garantire la conservazione delle aree a più elevata rilevanza ecologica.

DISCUSSIONE

Due sono i settori di preminente interesse ambientale nell'area osservata:

- Tulmaythah – Qasi ad Disah (zona A – B)
- Sidi Awn – Wadi el Hamassah (zona P – Q)

Sono i "punti di forze e di debolezza" riscontrati in questi due tratti di costa che dovrebbero indurre a procedere nei tempi più celeri ad avviarvici le attività di studio ed eventualmente di protezione preventiva delle emergenze naturalistiche più significative: ad Ovest il sistema di isolotti, scogli affioranti e di dune costiere; ad Est la scogliera, gli anfratti marini e relativi fondali.

In linea di massima, su tutta la costa esaminata, si può ritenere che il settore centrale (da C ad O inclusi) offre eccellenti opportunità per lo sviluppo sostenibile di attività legate al turismo culturale e – con opportune precauzioni – alla maricoltura. I settori marginali (A – B e P – Q), scarsamente sfruttati e con risorse ambientali notevoli, possono essere destinati a tutela ambientale senza che questo rischi di comportare un impatto negativo sulla popolazione residente.

Area di Tulmaythah – Qasi ad Disah

L'areale individuato dovrebbe prevedere un sistema di protezione della parte terrestre (sistema di dune costiere) e di quella marina prospiciente: spiagge, isolotti e scogli. Il piano Sopralitorale è caratterizzato, da un'analisi preliminare, dalla "Biocenosi delle sabbie sopralitorali" ed alcune delle sue facies:

– facies delle sabbie senza vegetazione, con detriti sparsi;
– facies dei tronchi d'albero spiaggiati;
– facies delle fanerogame che sono state spiaggiate (parte superiore).

Sottolineiamo la assoluta rarità, in tutto il Mediterraneo, di un ambiente così scarsamente antropizzato, con livelli di frequentazione bassissimi, di una tale estensione (60 km di costa) per quanto riguarda questa specifica tipologia di ambiente. In altri Paesi sarebbe da tempo stato oggetto di un intenso sfruttamento di tipo turistico, sul modello "Baleari" o "Rimini". La scarsa frequentazione non è dovuta a vincoli di proprietà od a servitù che privano in qualche modo la popolazione locale di un suo diritto di accesso che sarebbe altrimenti rivendicato, bensì è insita nella rapporto che la popolazione locale ha con l'ambiente del litorale, la sua bassa densità numerica, gli ambienti che essa tradizionalmente frequenta e la maniera di raffrontarsi con essi. E questo fintanto che modelli di sviluppo di altro tipo, estranei a questo contesto, non verranno importati e prenderanno il sopravvento.

Il Laboratorio Nazionale di Biologia Marina è già da tempo attivo in quest'area. Ha individuato e documentato importanti aree di deposizione di uova di tartarughe marine. Attualmente l'attività di monitoraggio ci sembra ben impostata ed eseguita annualmente con regolarità, nel corso dei periodi più significativi. Le serie storiche di dati sono state pubblicate e ci sono state rese disponibili.

E' questa quindi un'importante opportunità di collaborazione con le istituzioni scientifiche di riferimento: da un lato le azioni di tutela dell'ambiente devono basarsi su dati che documentano l'importanza ecologica di un sito e devono avvalersi di esperti che, con il loro monitoraggio, indichino il livello di efficienza delle azioni di conservazione intraprese. Dall'altro lato, avendo documentato l'unicità e l'importanza ecosistemica di questo sito, qualsiasi azione a livello nazionale ed internazionale che contribuisca ad elevare il grado di attenzione e di consapevolezza fino – auspicabilmente – al varo di norme di tutela ambientale specifiche, non può che convergere con quanto auspicato da parte degli studiosi locali.

Area di Sidi Awn – Wadi el Hamassah

All'estremo opposto dell'area precedente, è un lungo tratto di costa (circa 61 km) con caratteristiche geomorfologiche e biocenotiche del tutto differenti, ma comunque anch'esso scarsissimamente frequentato nel corso di tutto l'anno. Questo fatto ha mantenuto molto basso il livello di disturbo sulle biocenosi locali (qui tipicamente di substrato roccioso), cosa che è immediatamente stata percepita da tutta la squadra di lavoro al momento delle immersioni sui punti ispezionati. Difatti la parte costiera delle falesia non è raggiungibile da veicoli (la strada costiera passa, sull'altipiano, ad una decina di chilometri più all'interno) ne ci sono insediamenti abitati a Est di Darnah. La frequentazione per via mare, ad opera soltanto dei pescatori, è anch'essa piuttosto limitata, soprattutto nella fascia più vicina alla costa: il moto ondoso, alimentato dalle brezze costanti, è sempre piuttosto pronunciato, tanto che in porto di Darnah (che è l'unico approdo sino a Sidi Awn) sono presenti solo 5 barche da pesca, ma di stazza maggiore, adeguata a quel particolare e perenne stato del mare. Questo idrodinamismo costante sembra contribuire favorevolmente al contenimento dell'impatto negativo costituito dallo scarico del collettore fognario della città di Darnah, posto sul lato orientale del porto.

La conformazione scoscesa e frastagliata della falesia, la presenza di numerosi scogli e il mare regolarmente mosso non permettono ai pescatori di avvicinarsi più di tanto (100/200 metri) alla linea di costa, a tutto vantaggio delle aree di nursery e le biocenosi del piano infralitorale. Quindi anche qui siamo in una situazione in cui un eventuale decreto di protezione ambientale non sembra andarsi a scontrare con gli interessi attuali e consolidati di alcuno. Ma non è la quasi totale assenza di disturbo a rappresentare il punto di pregio ambientalistico di questo tratto di costa: oltre alle nursery areas, sono presenti numerose grotte e cavità regolarmente disseminate lungo la falesia, caratterizzate dalla biocenosi delle "Grotte semi-oscure"; molte di queste grotte presentano imboccature di accesso di grandi dimensioni: si potrebbe trattare di un tratto di costa ancora frequentato dalla Foca monaca, e a tal fine esistono programmi di ispezionare questo ed altri tratti di costa in Cirenaica.

CONCLUSIONE

Lungo la zona esaminata (province di Al Fatih, Jabal Al Akhdar e di Darnah), una corretta gestione della fascia costiera appare di difficile soluzione in quanto è il paesaggio litorale nel suo complesso che può essere considerato la risorsa più importante e, al tempo stesso, la più sfruttata. Si rischia di assistere a uno sviluppo incontrollato d'insediamenti residenziali o turistici, portuali e industriali che, nel tempo, entreranno in competizione con molti altri interessi economici: lo sfruttamento delle risorse biologiche (agricoltura, zootecnia, pesca, acquacoltura), di quelle minerarie ed il turismo.

Allegato 2: Elenco dell specie rinvenute.
Priloga 2: Popis najdenih vrst.

ZONA	A – B	C	D	E	F	G	H	I	L	M	N	O	P – Q
PESCI (Osteitti – Condroitti)													
Anguilla anguilla													1
Anthias anthias										1			1
Aphanius fasciatus	1	1											1
Balistes capriscus		1											
Blennius sanguinolentus		1								1			1
Boops salpa	1	1	1	1	1	1	1	1	1	1	1	1	1
Caranx crisos			1	1									
Chelon labrosus			1										
Chromis chromis	1	1				1		1	1	1	1	1	1
Coris julis		1				1						1	
Corvina nigra		1					1					1	1
Dentex dentex	1	1	1							1		1	1
Dentex macrophthalmus		1											
Dicentrarchus labrax									1			1	
Diplodus annularis	1	1	1	1	1	1	1	1	1	1	1		1
Diplodus cervinus cervinus	1	1	1	1	1	1	1	1	1	1	1	0	1
Diplodus vulgaris	1	1	1	1	1	1	1	1	1	1	1		1
Ephinephelus guaza	1	1	1	1	1	1	1	1	1	1	1	1	1
Epinephelus alexandrinus									1	1	1	1	
Epinephelus aeneus										1			
Exonautes rondeletii				1									
Fistularia commersoni				1	1		1						1
Gobius cobitis									1				
Holocentrus ruber	1												
Ionnius ololepidus												1	1
Labrus bergylta	1	1											
Labrus merula										1			
Lithognathus mormyrus		1	1				1				1	1	
Lobotes surinamensis										1	1		1
Mullus barbatus	1	1	1		1					1	1	1	
Mullus surmuletus			1										
Mycteroperca rubra										1			
Oblada melanura	1	1	1	1	1	1	1	1	1	1	1	1	1
Oedalechilus labeo										1	1		
Pelates quadrilineatus		1	1	1	1		1	1	1	1	1		1
Pagellus centrodonthus											1		
Pempheris vanicolensis	1	1								1			1
Pomadasys incisus													
Puntazzo puntazzo	1	1								1		1	
Scorpaena notata										1			
Scorpaena scropha	1												
Serranus cabrilla			1									1	1
Serranus scriba			1						1	1	1	1	1
Symphodus roissali	1	1	1	1	1	1	1	1	1	1	1		1
Siganus luridus										1			

ZONA	A – B	C	D	E	F	G	H	I	L	M	N	O	P – Q
Singanus rivulatus	1	1		1	1		1	1		1	1		1
Sparisoma cretense	1	1		1	1		1	1		1		1	1
Sparus aurata	1	1					1	1		1			
Sphyraena chrysotaenia	1	1	1			1							1
Spicara maena							1		1	1	1		1
Spondyliosoma cantharus	1	1	1	1					1	1	1		
Symphodus doderleini								1	1	1			
Symphodus melanocercus													
Symphodus ocellatus		1	1	1	1	1	1		1	1	1		1
Thalassoma pavo	1	1	1	1	1	1	1	1	1	1	1	1	1
Trachinus draco						1							
Tripterygion melanurus		1								1			
Xyrictis novacula													1
Squatina squatina										1			
Trigon pastinaca	1										1		
Rhinobatos rhinobatos	1												
Taeniura grabata	1												
ALGHE – FANEROGAME													
Acetabularia acetabulum	1	1				1				1	1	1	1
Anadiome stellata													1
Caulerpa racemosa						1	1						
Cladostephus verticillatus													1
Cutleria multifida											1		
Cystoseira barbata	1	1									1	1	
Cystoseira crinita		1											1
Cystoseira discors	1	1											1
Cystoseira fimbriata	1	1						1				1	1
Cystoseira mediterranea								1					1
Cystoseira spicata		1	1				1		1	1	1		1
Dasycladus clavaeformis			1								1		1
Dictyopteris membranacea	1	1					1	1	1	1		1	
Dictyota dichotoma		1	1	1							1	1	
Dictyota linearis	1	1	1	1	1	1	1	1	1	1	1	1	1
Dilophus fasciola		1	1	1		1							
Halimeda tuna										1	1	1	
Halopteris scoparia	1	1						1		1			
Jania rubens		1	1	1	1		1		1	1	1		1
Laurencia obtusa										1			
Liagora viscida				1		1					1		
Nemalion helmintoides													1
Nemastoma dichotoma	1			1	1								1
Padina pavonia		1	1	1	1		1		1	1	1	1	1
Ritiphlea tinctoria							1						
Sargassum vulgare	1	1	1	1		1	1	1	1				
Udotea petiolata											1		1
Posidonia oceanica	1	1	1		1	1			1				1
Cymodocea nodosa						1							

ZONA	A – B	C	D	E	F	G	H	I	L	M	N	O	P – Q
INVERTEBRATI (indicatori di bioqualità)													
Spongia officinalis			1	1						1			1
Hippospongia communis													
Spongia zimocea					1								
Spirastrella cunctatrix	1		1			1		1	1	1			1
Caryophillia inornata											1		
Monodonta turbinata			1	1	1		1	1	1	1	1		1
Patella vulgata	1		1			1					1		
Vermetus triqueter	1	1	1			1		1	1	1	1		1
Serpulorbis arenarius										1			
Charonia nodifera										1			
Conus mediterraneus	1	1	1	1	1	1	1	1	1	1	1	1	1
Scyllarides latus					1		1						
Paracentrotus lividus													1
Arbacia lixula	1	1	1			1		1					1
Cidaris cidaris												1	

UPORABA SISTEMOV ZA OCENJEVANJE KAKOVOSTI MORSKEGA OBREŽJA CIRENAJKE (JAMAHIRIJA, LIBIJA – JUGOVZHODNO SREDOZEMLJE) S KAZALNIKI KRAJINSKE EKOLOGIJE

Saul CIRIACO, Claudio FRANCI, Carlo FRANZOSINI, Erik MERSON & Roberto ODORICO
SHORELINE soc. coop. – CeRQuAM (Centro di Ricerca per la Qualità dell'Ambiente Marino), Area Science Park,
I-34012 Trieste, Padriciano 99, Italia
E-mail: shoreline@shoreline.it

POVZETEK

Na osnovi "Analize sredozemske morske vrzeli", ki jo je opravil Svetovni sklad za naravo (WWF), sodi obrežje libijske Cirenajke med 13 najpomembnejših in najznačilnejših obrežnih območij Sredozemskega morja. Z namenom, da se karseda konsolidira predlog o odprtju novih obrežnih in morskih zaščitenih območij, je WWF v sodelovanju z Libijskim uradom za okolje (EGA) in organizacijo Shoreline junija 2004 napravil hitro oceno biotske pestrosti cirenajškega obrežja.

Obrežni pas Cirenajke je bil razdeljen na 15 sektorjev (A – Q), ki jih je potem analizirala in na mestu samem dokumentirala skupina potapljačev. Da bi ocenila okoljske značilnosti območja, je pregledala skoraj 280 km obrežja. Analiza morskih komponent je bila opravljena na osnovi inšpekcij na 66 vzorčevalnih postajah. Pet vizualnih inšpekcij je bilo opravljenih tudi z daljinsko vodenim vozilom (Remotely Operated Vehicle – R.O.V.).

Ogledi na mestu samem so pokazali, da je ekološki sistem še vedno takšen, da naravnega okolja človekova navzočnost ne more bistveno spremeniti, in sicer zaradi različnih faktorjev, povezanih z majhno urbanizacijo ter omejeno količino odplak in odpadkov. Vse manjšo velikost organizmov pa je mogoče v glavnem pripisati bolj splošno razširjeni oligotrofiji kot poškodbam v ekosistemu. Podlaga je v glavnem revna s sesilnimi nevretenčarji in še posebej organizmi, ki se hranijo s precejanjem hranil, medtem ko je vegetacija – ki sicer ni ravno bogata – zelo zanimiva in ji dajejo posebno značilnost tudi različne vrste iz rodu Cystoseira.

Vrednost vzorčevalne postaje je bila določena s kakovostjo njenih komponent na osnovi naslednjih faktorjev:

1) Tip podlage – 1a) Diverziteta tipa podlage

2) Fizionomija vegetacije – 2a) Raznolikost vegetacije
3) Pokrovnost sesilnih živali – 3a) Raznolikost v pokrovnosti sesilnih živali
4) Številčnost ribjih vrst – 4a) Raznolikost ribjih vrst
5) Zunanja pokrovnost vegetacije
6) Človeški vpliv

Odkriti sta bili dve območji posebnega okoljskega pomena: Tulmaythah – Qasi ad Disah (sektor A – B) in Sidi Awn – Wadi el Hamassah (sektor P – Q).

Območje Tulmaythah – Qasi ad Disah: to območje bi moralo zajemati tako zaščito kopnega (sistem obrežnih sipin) kot morja: plaž, otočkov in skal. Tu je treba poudariti, da je v Sredozemlju zelo težko najti tako široko območje (60 km obrežja) s takšnim specifičnim okoljem, kjer je človeški vpliv tako omejen. V tem območju že dolgo deluje Morski biološki laboratorij, ki je identificiral in dokazal obstoj pomembnih gnezdišč morskih želv.

Območje Sidi Awn – Wadi el Hamassah: na zahodni strani obiskanega območja se razteza dolg pas obrežja (kakih 61 km), ki se močno razlikuje od drugih tako po svojih geomorfoloških kot biocenotskih značilnostih in kjer je prek celega leta močno omejena tudi človekova navzočnost. Obrežno območje s klifi ni dostopno po cesti, saj se obalna cesta vije prek goratega predela kakih deset kilometrov od morja, poleg tega pa tudi ni najti nobenih naselij vzhodno od kraja Darnah. Dostop do območja je po morju omogočen samo ribičem, in še ta je omejen, posebno v predelu, ki leži bliže obrežju. Pa vendar ta zelo omejena raven vznemirjanja ni glavna okoljska kakovost tega dela obrežja, saj je ob teh razmnoževalnih okoljih v klifih najti mnoge jame in votline, ki gostijo biocenoze "poltemnih jam": mnoge izmed njih imajo velike vhode in v njih morda še vedno živi tudi medvedjica.

Ključne besede: krajinska ekologija, hitra ocena obrežne biodiverzitete, sredozemska obala, Libija, Cirenajka

BIBLIOGRAFIA

Boca, D. & G. Oneto (1990): Analisi paesaggistica: manuale per la preparazione dei piani paesaggistici e altre operazioni di architettura del paesaggio. Pirola, Milano.

Finke, L. (1993): Introduzione all'ecologia del paesaggio. Franco Angeli Ed., Milano.

Franzosini, C., R. Odorico, M. Spoto, M. Tempesta, P. Guglielmi, M. A. Thili & S. Ciriaco (2001): A GIS approach for marine conservation areas in the Mediterranean ecoregion. ICES Annual Science Conference, 26–29 September 2001, Oslo, Norway. ICES CM 2001/Y: 06.

Harmelin-Vivien, M. L. & P. Francour (1992): Trawling or visual census? Methodological bias in the assessment of fish population in seagrass beds. P.S.Z.N.I: Mar. Ecol., 13(1), 41–51.

http://www.worldwildlife.org/science/ecoregions/global200.html

McHarg, I. (1969): Design with Nature. Doubleday/Natural History Press, New York.

Merson, B. (2003): Analisi paesaggistica della costiera di Muggia (TS): studio integrato della fascia marino-terrestre da Porto S. rocco al valico di S. Bartolomeo. Tesi di Laurea. Università degli Studi di Trieste, Facoltà di Scienze, Trieste.

Merson, E. (2002): Stima del valore naturalistico marino-terrestre della baia di Sistiana: una proposta metodologica. Tesi di Laurea. Università degli Studi di Trieste, Facoltà di Scienze, Trieste.

Odorico, R., A. Turello & S. Ciriaco (2001): PTRP – Piano Territoriale Regionale Particolareggiato: aspetti marino-costieri e sensibilità della costa. Regione Friuli Venezia Giulia, 120 p.

Pérès, J. M. & J. Picard (1964): Nouveau manuel de bionomie benthique de la Mer Méditerranée. Rev. Trav. St. Mar. Endoume, 31(47), 5–137.

Romanini, V. (1994): Il paesaggio: teoria e pianificazione. Franco Angeli Ed., Milano.

Tyler-Walters, H., K. Hiscock, D. B. Lear & A. Jackson (2001): Identifying species and ecosystem sensitivities. Report to the Department for Environment, Food and Rural Affairs from the Marine Life Information Network (MarLIN), Marine Biological Association of the United Kingdom, Plymouth.

Izvirni znanstveni članek
Prejeto: 2008-04-23

UDK 504.7:546.214(497.4-14)

OCENA ONESNAŽENOSTI ZRAKA Z OZONOM V OBMORSKEM DELU SLOVENIJE Z UPORABO PASIVNIH VZORČEVALNIKOV

Agnes ŠÖMEN JOKSIĆ
Zavod za zdravstveno varstvo Koper, SI-6000 Koper, Vojkovo nabrežje 4a
in
Univerza na Primorskem, Visoka šola za zdravstvo Izola, SI-6310 Izola, Polje 42, Slovenija
E-mail: agnes.somen@zzv-kp.si

Franka CEPAK
Zavod za zdravstveno varstvo Koper, SI-6000 Koper, Vojkovo nabrežje 4a, Slovenija

Smiljana ŠKVARČ
Univerza na Primorskem, Primorski inštitut za naravoslovne in tehnične vede, SI-6000 Koper, Muzejski trg 2, Slovenija

IZVLEČEK

Ocenjena je kakovost zraka zaradi onesnaženosti z ozonom na osnovi pasivnega vzorčenja na posameznih območjih obmorskega dela Slovenije in zaledja. Statistično ovrednotenje indikativne metode je temeljilo na primerjavi rezultatov meritev z dvema vrstama pasivnih vzorčevalnikov in primerjavi rezultatov pasivnih meritev z rezultati avtomatskih meritev. Rezultati se medsebojno dobro ujemajo, metoda izpolnjuje zahteve evropske zakonodaje glede kakovosti pridobljenih podatkov za spremljanje stanja kakovosti zraka na različnih lokacijah južne Primorske, kjer avtomatske meritve niso zagotovljene. Najnižje koncentracije ozona, okrog 80 µg/m^3, so bile izmerjene ob obali in na lokacijah, obremenjenih s prometom, srednje koncentracije okrog 120 µg/m^3 so bile izmerjene na višjih legah in v notranjosti, najvišje koncentracije, med 120 in 180 µg/m^3, pa so bile izmerjene na višjih obalnih legah, zlasti na legah z značilnostmi proti morju odprte atmosfere in na lokacijah, neobremenjenih s prometom.

Ključne besede: ozon, pasivni vzorčevalniki, indikativne meritve, onesnaženje zraka

VALUTAZIONE DELL'INQUINAMENTO DA OZONO DELL'ARIA NELLA REGIONE COSTIERA SLOVENA CON L'AUSILIO DI CAMPIONATORI PASSIVI

SINTESI

L'articolo presenta la valutazione della qualità dell'aria in relazione all'inquinamento da ozono, con l'ausilio di campionatori (di diffusione) passivi, in determinate aree della costa slovena e dell'entroterra. La valutazione statistica del metodo indicativo è basata sul confronto dei risultati delle misurazioni effettuate con due tipi di campionatori passivi e sul confronto fra i risultati delle misurazioni passive e i risultati delle misurazioni automatiche. Fra di loro i risultati combaciano bene, ed il metodo soddisfa le richieste della legislatura europea in merito alla qualità dei dati ottenuti per il monitoraggio dello stato qualitativo dell'aria in diverse aree del Litorale meridionale, dove le misurazioni automatiche non vengono effettuate. Le concentrazioni più basse di ozono, circa 80 µg/m^3, corrispondono a località soggette a traffico intenso. Concentrazioni intermedie, pari a circa 120 µg/m^3, sono tipiche dell'entroterra, mentre le concentrazioni di ozono più elevate, tra 120 e 180 µg/m^3, sono state registrate in aree costiere a quota più alta, rivolte al mare e non soggette a traffico intenso.

Parole chiave: ozono, campionatori passivi, misurazioni indicative, inquinamento dell'aria

UVOD

Ozon postaja eden izmed najpomembnejših in najbolj zaskrbljujočih onesnaževal zunanjega zraka v Evropi. Nastaja s fotokemično reakcijo iz dušikovih oksidov (najpomembnejši vir je promet) in lahkohlapnih organskih snovi (industrija, promet, bencinske črpalke in naravni viri, na primer vegetacija) (Günther *et al.,* 2000; Mohamed *et al.,* 2002), ki jim zato pravimo predhodniki ozona oziroma prekurzorji. Vremenske razmere so poleg emisij predhodnikov ozona in atmosferske kemije glavni povzročitelj rednega pojavljanja povišanih koncentracij ozona v zraku, kar se v poletnem času redno dogaja zlasti na Primorskem (ARSO, 2007b). Ozon je sicer problem celotne Evrope (EEA, 2007). V letu 2006 so bile skoraj v vsaki državi skoraj vsak poletni mesec in na večini merilnih postaj v severozahodni in južni Evropi v poletnem času povišane koncentracije ozona, ki redno presegajo opozorilno vrednost za enourno povprečje, OV (180 μg/m^3) in alarmno vrednost za enourno povprečje, AV (240 μg/m^3) (glej Tabelo 1).

V nekaterih raziskavah so avtorji pokazali, da se vrednosti ozona na posameznih mikrolokacijah zelo razlikujejo od vrednosti, izmerjenih na merilnih mestih v sklopu mreže avtomatskih merilnih postaj (Liu, *et al.,* 1993, 1997; Weschler, 2004). Poleg tega je pomanjkljivost avtomatskih meritev v tem, da ne upoštevajo prostorskih sprememb v koncentracijah ozona, ki jih povzročajo letne razlike emisijskih razmer in meteoroloških razmer ter razlike med urbanim in ruralnim okoljem (Sather *et al.,* 2001). Meritve na stalnih lokacijah tudi ne upoštevajo razlike v koncentracijah v notranjem in zunanjem zraku, kakor tudi ne različnih vzorcev aktivnosti na osebno izpostavitev, kar je pomembno na primer pri oceni vpliva onesnaženosti zraka na zdravje ljudi (Weschler *et al.*, 1989; NC DHHS, 1999).

Za dopolnitev teh podatkov obstajata dva načina: a) razširitev mreže oziroma postavitev dodatnih avtomatskih oziroma kontinuirnih vzorčevalnikov na izbranih lokacijah, kar je z ekonomskega vidika neugodno, saj so stroški postavitve in obratovanja takih merilnikov previsoki, poleg tega pa še vedno ni odpravljen problem reprezentativnosti podatkov na lokalni ravni, in b) z uporabo pasivnih oziroma difuzivnih vzorčevalnikov in sistema indikativnih meritev (EC, 2002), s čimer je omogočena ocena onesnaženja na posameznih mikrolokacijah širšega območja ob veliko manjših stroških in z možnostjo zanesljivejše ocene potencialne izpostavljenosti ljudi. Prednost pasivnih vzorčevalnikov je, da ne potrebujejo sistemov črpalk in napajanja, ne potrebujejo nadzora, z njimi je mogoče zajeti 100-odstotni čas merjenja in široko koncentracijsko območje (od 2 do 400 μg/m^3) (Brown, 1993; Koutrakis *et al.*, 1993). Njihova prednost je tudi v majhnosti ter preprostosti postavitve. Opravljeni testi in validacije za večtedensko spremljanje (Buzica *et al.*, 2005; Gerboles *et al.*, 2006) so omogočili uporabo pasivnih vzorčevalnikov tako v dopolnilni mreži monitoringov kakovosti zraka (ARSO, 2007a) kot v shemah okolje-zdravstvenih monitoringov (Brown, 2000; Helaleh *et al.*, 2002). Glavna pomanjkljivost pasivnih vzorčevalnikov je, da ne zagotavljajo podatkov o povprečnih urnih vrednostih posameznega onesnaževala, temveč skupno koncentracijsko povprečje za čas izpostavljenosti vzorčevalnika. Iz tedenskih meritev na osnovi pasivnih vzorčevalnikov je sicer mogoče s pomočjo statističnih testov izdelati histograme urnih porazdelitev ozona (Krupa *et al.,* 2003; Olcese & Toselli, 2006), vendar je za to potrebno načrtno in dolgotrajnejše zbiranje podatkov pasivnih meritev.

Namen raziskave je bil ovrednotiti uporabnost pasivnih vzorčevalnikov v oceni onesnaženost zraka z ozonom na lokacijah, kjer avtomatske meritve niso zagotovljene. Cilj je vzpostaviti sistem indikativnih meritev ozona (indikativne meritve so meritve, ki se opravljajo manj pogosto, vendar izpolnjujejo druge cilje glede kakovosti podatkov) z izbrano vrsto pasivnih vzorče-

Tab. 1: Zakonodajne omejitve koncentracij ozona v zunanjem zraku (EC, 2002; Uradni list RS, 2003).
Tab. 1: Legislative limits for ozone in ambient air (EC, 2002; Official Gazette of RS, 2003).

Parameter	**Opis**	**Mejna vrednost (omejitev)**
Opozorilna vrednost	1-urno povprečje meritev	180 μg/m^3
Alarmna vrednost	1-urno povprečje meritev	240 μg/m^3
Ciljna vrednost za varovanje zdravja ljudi	največja dnevna 8-urna srednja vrednost	120 μg/m^3 ne sme biti presežena več kot v 25 dneh v koledarskem letu, izračunano kot povprečje v obdobju treh let – velja do 2010
Ciljna vrednost za varstvo rastlin	AOT40, izračunan iz 1-urnih vrednosti v odbobju od maja do julija	18.000 (μg/m^3).h kot povprečje v obdobju petih let – velja do 2010
Dolgoročno naravnana vrednost za varovanje zdravja ljudi	največja dnevna 8-urna srednja vrednost v koledarskem letu	120 μg/m^3
Dolgoročno naravnana vrednost za varstvo rastlin	AOT40, izračunan iz 1-urnih vrednosti v odbobju od maja do julija	6.000 (μg/m^3).h

valnikov na širšem območju južne Primorske, s čimer bi pridobili in v prihodnje spremljali prostorsko sliko kakovosti zraka na tem območju v obdobju pojavljanja povišanih koncentracij ozona v zunanjem zraku. Za uvedbo indikativnih meritev ozona je treba dokazati, da negotovost, vključno z negotovostjo zaradi občasnega vzorčenja, izpolnjuje cilj kakovosti, to je doseganje 30% merilne negotovosti za povprečje posameznih meritev za 95% interval zaupanja (EC, 2002). V ta namen smo primerjali rezultate pasivnih meritev z uporabo dveh komercialno dostopnih pasivnih vzorčevalnikov, in sicer vzorčevalnikov tipa Radiello (RAD1235) in difuzivnih vzorčevalnikov tipa Gradko (DIF 300RTU-Ozone). Slednji so bili po izpostavitvi analizirani v referenčnem laboratoriju v Angliji, vzorčevalniki Radiello pa so bili analizirani v lastnem laboratoriju. Opravili smo tudi validacijo metode določevanja skupnih koncentracij ozona v zraku na osnovi pasivnega vzorčenja z vzorčevalniki Radiello. Rezultate meritev na osnovi pasivnega vzorčenja smo primerjali tudi z rezultati avtomatskih (kontinuirnih) meritev.

METODE DELA

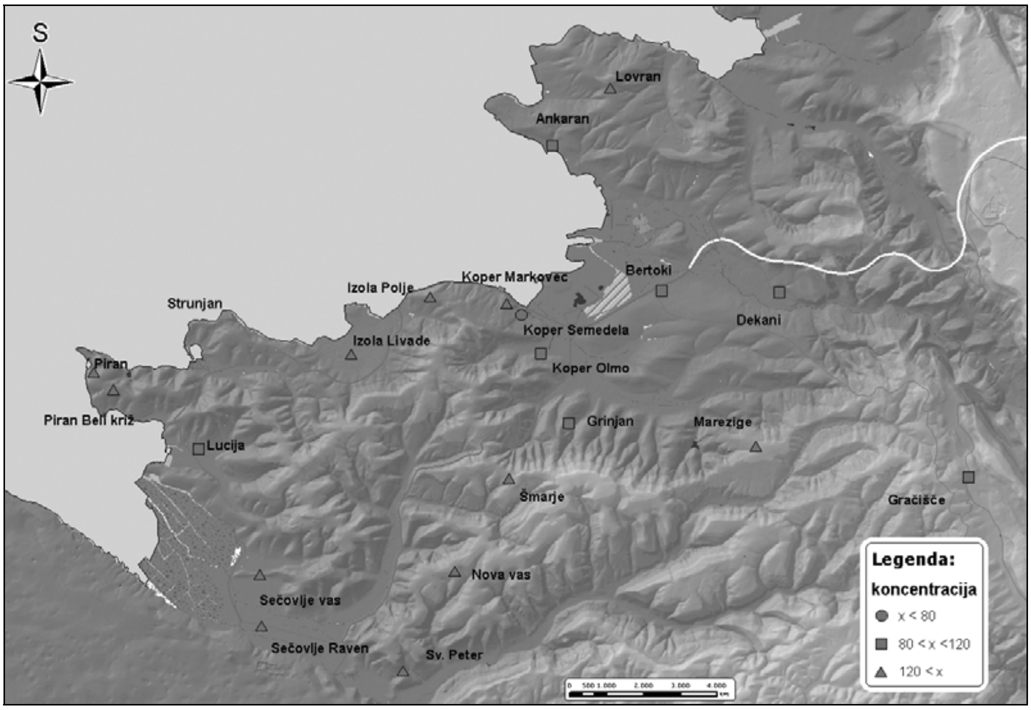
Merilna mesta

Vzorčevalnike smo namestili na 19 merilnih mestih na območju južne Primorske na površini približno 130 km^2 (Sl. 1). Pri izbiri merilnih mest je bila upoštevana klasifikacija merilnih mest v skladu s smernicami (EEA, 1999), tako da so bila zastopana predvsem stanovanjska oziroma bivalna območja v mestnih, primestnih in podeželskih okoljih. Vzorčevalniki so bili izpostavljeni od 9. do 25. julija 2007.

Na vsakem merilnem mestu smo izpostavili tri vzorčevalnike. Po končani izpostavitvi smo vzorčevalnike analizirali v laboratoriju v skladu s postopkom, opisanem v nadaljevanju. Vzporedno smo spremljali tudi meteorološke podatke (smer vetra, hitrost vetra, temperatura) in koncentracije ozona v realnem času z avtomatske postaje v Kopru ter z mobilne postaje v Lovranu nad Ankaranom.

Postopek določitve ozona s pasivnim vzorčenjem

Pasivni vzorčevalniki tipa Radiello (RAD1235) so sestavljeni iz mikroporozne polietilenske cevke, napolnjene s silikagelom, obdelanim s 4,4-dipiridiletilenom. Cevka (dolžina 60 mm, širina 20 mm) je na eni strani zaprta s PTFE-pokrovom. Pri izpostavitvi zrak prehaja skozi porozne stene cevke v notranjost, kjer zaradi ozona poteče kislinsko katalizirana reakcija 4,4-dipiridiletilena v 4-piridilaldehid. Nastali 4-piridilaldehid smo določali v laboratoriju po predhodni reakciji s 3-metil-2-benzotiazolinon hidrazinom. Absorbanco raztopine smo določali spektrofotometrično pri 430 ± 5 nm s spektrometrom Perkin Elmer Lambda Bio 20 v 1 cm kiveti. Reakcija je selektivna in specifična za ozon. V zraku



Sl. 1: Merilna mesta na območju južne Primorske in koncentracije ozona v zraku v µg/m^3.
Fig. 1: Measuring sites in the South Primorska region and concentrations of ozone in ambient air in µg/m^3.

pojavljajoči se NO_2 ali organske snovi ne motijo določitve. Povprečno koncentracijo ozona v celotnem obdobju izpostavljenosti smo izračunali po spodnji enačbi:

$$C[\mu g / m^3] = \frac{m[\mu g]}{Q[ml/\min] \cdot t[\min]} \cdot 1.000.000$$

kjer je:

m = masa ozona v µg; *Q* = hitrost vzorčenja – eksperimentalno določena referenčna vrednost, ki je pri 25 ˚C (298 ˚K) in 1013 hPa 24,6 ml/min (Detimmerman *et al.*, 2000); *t* = čas izpostavljenosti v minutah.

Validacija metode določanja ozona s pasivnim vzorčenjem

Pred izvedbo analize je bila opravljena validacija metode (EURACHEM, 1998; Barwick & Ellison, 2000; EURACHEM/CITAC, 2000). Kot kriterij ustreznosti izbrane metode smo opredelili zahtevo evropske direktive (EC, 2002), ki za indikativno, torej pasivno metodo dopušča največ 30% merilne negotovosti meritev. Vsi uporabljeni reagenti za izvedbo meritev so bili ustrezne analitske čistosti in uporabljena oprema ustrezno kalibrirana. Umeritvena krivulja za spektrofotometrično določitev ozona je bila izdelana na sedmih ravneh, in sicer med 10 in 100 µg O_3. Za standardno raztopino je bil uporabljen 4-piridilaldehid, pri čemer 1 µg predstavlja 0,224 µg O_3. Premica je linearna, koeficient korelacije (r) regresijske premice znaša ≥ 0,999. Ponovljivost realnih vzorcev, izražena kot relativna standardna deviacija, je znašala ± 15% v celotnem koncentracijskem območju. Kot slepi vzorci so bili uporabljeni pasivni vzorčevalniki, ki niso bili izpostavljeni okolju. Meja detekcije za 7-dnevno izpostavljenost je 2 µg/m^3. Izračunana razširjena merilna negotovost metode (pri intervalu zaupanja 95%) znaša 26%.

Zagotavljanje kakovosti meritev

Pasivne meritve

Na vseh merilnih mestih so bili izpostavljeni po trije difuzivni vzorčevalniki. Analize so bile opravljene v 24 urah po zaključenem vzorčenju, sicer je mogoče vzorce v zaprtih epruvetah in v temi hraniti en teden. Pred vsako analizo smo predhodno opravili analizo slepega vzorca in dveh kontrolnih vzorcev. Vpliv temperature na hitrost vzorčenja smo upoštevali v skladu z enačbo:

$$Q_K = Q_{298} \cdot \left(\frac{K}{298} \right)^{1,5}$$

kjer je Q_K hitrost vzorčenja pri temperaturi *K*, Q_{298} pa je referenčna vrednost pri 298 ˚K. Izračun z upoštevanjem izmerjenih najvišjih, najnižjih in povprečnih dnevnih temperatur je pokazal, da temperatura 20 ˚C oziroma 31 ˚C ne vpliva bistveno na končni rezultat, ker je izračunana razlika manjša od napake ponovljivosti metode (RSD = 15%). Ravno tako na hitrost vzorčenja bistveno ne vplivajo relativna vlaga v območju 15–90% in hitrosti vetra med 0,1 in 10 m/s (Detimmerman *et al.*, 2000).

Avtomatske meritve

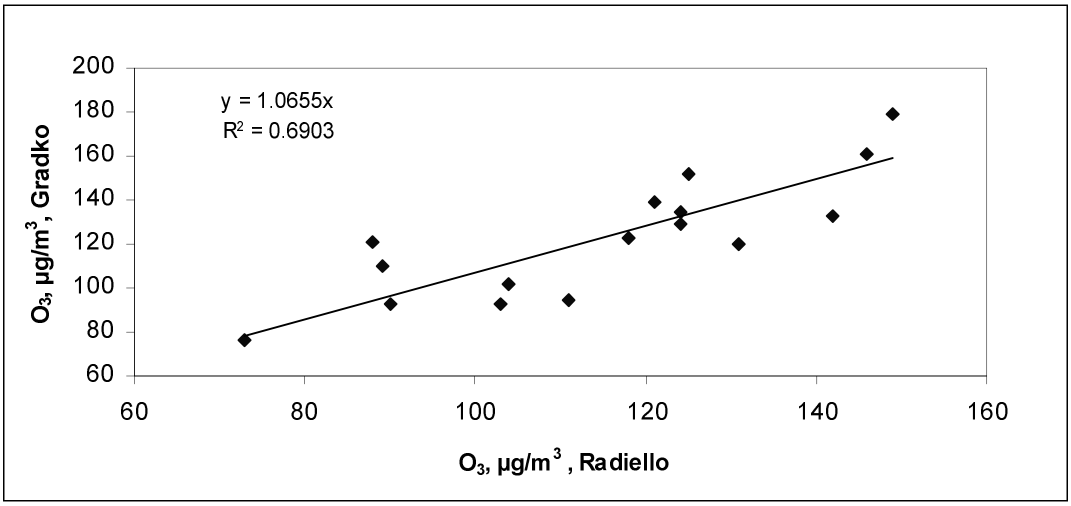
Avtomatske meritve ozona se opravljajo v sklopu mreže avtomatskih merilnih postaj Državne mreže za kakovost zraka (DMKZ) pod pokroviteljstvom ARSO. Meritve na avtomatski postaji temeljijo na metodi UV-fotometrije in se opravljajo v skladu s standardom SIST EN 14625:2005, meja detekcije je 2 µg/m^3 (ARSO, 2007b). Ozon je treba meriti s ± 5% točnostjo in s ± 5% natančnostjo pri vrednostih, ki so večje od 42,8 µg/m^3, in ± 4,3 µg/m^3 za območje meritev od 2 do 42,8 µg/m^3. Točnost in natančnost se določi enkrat na leto, in sicer s primarnim standardom za ozon. Merilnike avtomatske postaje se kalibrira oziroma preverja na merilnem mestu v skladu s predpisano zakonodajo in standardi ter na medlaboratorijskih primerjavah. Podrobnejše zahteve za zagotavljanje kakovosti podatkov za meritve ozona so podane v EMEP (European Monitoring and Evaluation Programme) manual for sampling and chemical analysis in v poročilu Global Atmosphere Watch: Quality Assurance Project Plan (QAPjP) for Continuous Ground Based Ozone Measurements. Geneva: World Meteorological Organization, Global Atmosphere Watch, Report No. 97 (ARSO, 2007c).

REZULTATI IN RAZPRAVA

Primerjava rezultatov meritev ozona z dvema vrstama pasivnih vzorčevalnikov

Postopek določanja vsebnosti ozona s pasivnimi vzorčevalniki Gradko temelji na določitvi kemijsko absorbiranih nitratov z ionsko kromatografijo, pri čemer je koncentracija nitratov sorazmerna koncentraciji ozona (Gradko Technical Data Sheet, TDS 6). Določanje vsebnosti ozona s pasivnimi vzorčevalniki Gradko je opravil laboratorij, ki je akreditiran za opravljanje te metode skladno z zahtevami ISO/IEC 17025.

Primerjava rezultatov meritev ozona z obema vrstama pasivnih vzorčevalnikov, Gradko in Radiello, je prikazana na sliki 2 (n = 16, p = 0,05, r = 0,69). Tudi statistična primerjava parov meritev, opravljenih z različnima metodama, pokaže, da med načinoma določitve ni značilnih razlik pri 95% stopnji zaupanja (n-1 = 15; $i_{izračunan}$ = 2,00; $t_{eoretičen}$ = 2,13).



Sl. 2: Primerjava rezultatov pasivnih meritev koncentracije ozona v zraku, µg/m^3, z vzorčevalniki Radiello in vzorčevalniki Gradko na različnih merilnih mestih v obdobju od 9. do 25. julija 2007.
Fig. 2: Ozone concentrations, µg/m^3, in the air – comparison of the results, as obtained by two different types of passive samplers at selected sites from 9th to 25th July, 2007.

Primerjava rezultatov pasivnih meritev ozona z rezultati avtomatskih meritev

V Tabeli 2 so zbrani rezultati meritev s pasivnimi vzorčevalniki Radiello, namen katerih je bil ugotoviti primerljivost z rezultati avtomatskih meritev. Izmerjeno skupno koncentracijo ozona smo primerjali s povprečnimi koncentracijami, izmerjenimi z avtomatskimi meritvami na merilnih postajah za kakovost zraka na Markovcu in v Lovranu.

Tab. 2: Primerjava povprečnih koncentracij ozona, µg/m^3, izmerjenih v različnih časovnih obdobjih s pasivnimi vzorčevalniki in z avtomatskimi meritvami.
Tab. 2: Comparison of average concentrations of ozone, µg/m^3, measured in different time periods by diffusive and continuous sampling.

Obdobje	**Pasivne meritve Radiello (µg/m^3)**	**SD (µg/m^3)**	**Avtomatske meritve* (µg/m^3)**
Markovec			
14.5.–21.5.07	95	12	86
20.6.–22.6.07	117	15	90
9.7.–25.7.07	124	19	102
Lovran			
14.5.–21.5.07	98	15	103
21.6.–22.6.07	101	16	99
9.7.07–25.7.07	146	19	124

*Razširjena negotovost avtomatskih meritev koncentracij ozona v zraku za meritve ozona v letu 2007 še ni izračunana (A. Planinšek, *osebno*). Preostali podatki o zagotavljanju kakovosti avtomatskih meritev so opisani v točki Zagotavljanje kakovosti meritev in v poročilih Agencije RS za okolje (ARSO, 2007b, 2007c).

Statistična primerjava parov meritev, opravljenih z različnima metodama, pokaže, da med načinoma določitve ni značilnih razlik pri 95% stopnji zaupanja (n-1 = 5; $i_{zračunan}$ = 2,46; $t_{eoretičen}$ = 2,57). Na podlagi opravljene primerjave smo ocenili, da metoda določanja koncentracij ozona z izbranimi pasivnimi vzorčevalniki izpolnjuje zahteve evropske direktive 2002/3/EC, ki za indikativno, torej pasivno metodo dopušča največ 30% merilne negotovosti meritev. Zaradi tega pasivnih vzorčevalnikov nismo kalibrirali glede na vrednosti iz avtomatskih meritev.

Koncentracije ozona, izmerjene z avtomatskim meritvami, in meteorološki parametri v obdobju opravljanja pasivnih meritev

Avtomatske meritve ozona se opravljajo na avtomatski meteorološki postaji na Markovcu v Kopru in na mobilni meteorološki postaji v Lovranu nad Ankaranom. V času pasivnih meritev so bile zabeležene najvišje koncentracije ozona v drugi polovici merilnega obdobja, med 19. in 20. julijem. Koncentracije ozona in temperature, izmerjene na obeh merilnih postajah, so prikazane v Tabeli 3.

Iz Tabele 3 je razvidno, da je povprečna koncentracija ozona, izmerjena v obdobju med 9. in 25. julijem 2007 na avtomatski merilni postaji v Kopru in na Lovra-

Tab. 3: Koncentracije ozona, μg/m^3, ter povprečna in maksimalna dnevna temperatura zraka, izmerjene na avtomatskih merilnih postajah v Kopru in Lovranu v obdobju od 9. do 25. julija 2007.
Tab. 3: Concentrations of ozone, μg/m^3, and average and maximum daily temperatures at the automatic measuring stations in Koper and Lovran from 9th to 25th July, 2007.

Parameter	Koper	Lovran
Povprečna konc. O_3	**102**	**124**
Max urna konc	243	255
Urna > OV	6	38
Urna > AV	1	1
Max dnevna	143	160
Max 8 ur	180	203
Max 8 ur > CV	10	15
AOT40	9440	13720
Povprečna T (°C)	26	25
Max dnevna T (°C)	31	31
Skupna konc. – pasivne meritve	**124**	**146**

nu, znašala 102 oziroma 124 μg/m^3, skupna koncentracija ozona, izmerjena v istem obdobju s pasivnimi meritvami, pa 122 oziroma 146 μg/m^3 (odstopanje med meritvami znaša 20 oziroma 18%).

Primerjava z meteorološkimi podatki

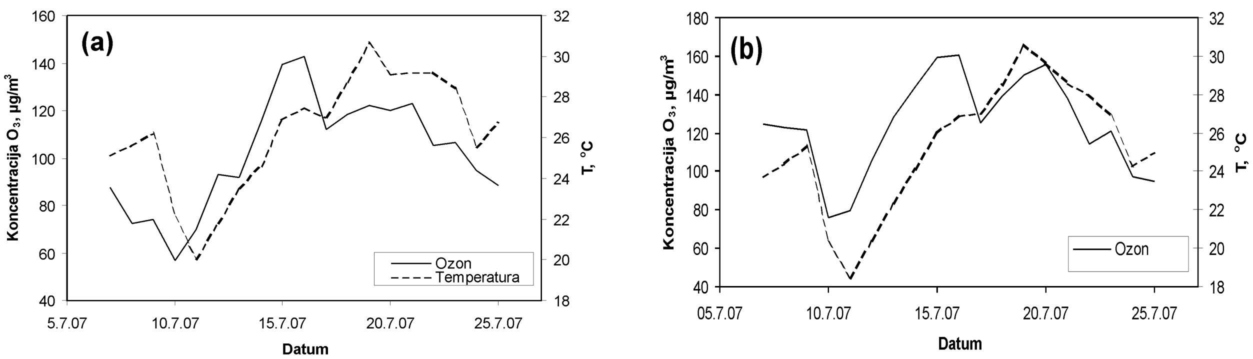
Temperatura

V obdobju meritev je bila povprečna temperatura na območju Kopra in Lovrana 26 oziroma 25 °C, najvišja dnevna temperatura pa je bila na obeh lokacijah 31 °C. Pojavljanje ozona in povprečne dnevne temperature v obdobju meritev na merilnem mestu avtomatske postaje na Markovcu v Kopru prikazuje slika 3a, na avtomatski postaji Lovran nad Ankaranom pa slika 3b. Iz slik je razvidno, da koncentracije ozona oziroma pojavljanje ozona ob jasnem, sončnem vremenu sledi temperaturnemu gibanju in da se običajno visoke koncentracije ozona ujemajo z visokimi temperaturami zraka.

Visoke temperature pa niso edini pogoj za nastanek ozona. Kot eden izmed produktov nastaja ozon v ozračju namreč v kompleksnem nizu procesov pod vplivom ultravijolične svetlobe, zato je njegova koncentracija navadno povečana v jasnih poletnih dneh z veliko sončnega sevanja (Copper & Alley, 1994). V času meritev je bilo večinoma jasno vreme (ARSO, 2007b), zato sklepamo, da so visoke temperature spremljale v glavnem jasne dni, z veliko sončnega sevanja, kar je ena od značilnosti stabilnega poletnega vremena. Soodvisnosti sončnega sevanja in koncentracij ozona v okviru te raziskave nismo spremljali, vendar smo s primerjavo koncentracij ozona v različnih dneh junija 2006, v obdobju tako imenovanih ozonskih epizod, in v juliju 2007, v obdobju opravljanja meritev, pokazali, da se ozon v ugodnih meteoroloških razmerah v zraku 'kopiči' oziroma se koncentracija ozona ponoči, ko ni sončnega sevanja, ne zniža (glej sliki 7 in 8 ter razpravo v nadaljevanju).

Veter

Na območju avtomatske merilne postaje na Markovcu v Kopru je v času opravljanja pasivnih meritev prevladoval severozahodni veter, maestral, ki običajno prevladuje tudi ob visokih izmerjenih koncentracijah ozona. Slika 4a prikazuje rožo onesnaženja (povprečne koncentracije ozona) pri različnih hitrostih vetra, slika 4b pa vetrovno rožo za dve ravni koncentracij (pogos tost smeri vetra) za koncentracije, ki so višje od 95 percentila oziroma nižje od 10 percentila koncentracije ozona na stalnem merilnem mestu Markovec pri Kopru. Pri tem velja, da je 95 percentil vseh koncentracij tista izračunana vrednost iz niza podatkov, od katerih ima 95% vseh meritev nižjo ali enako vrednost, 5% vseh



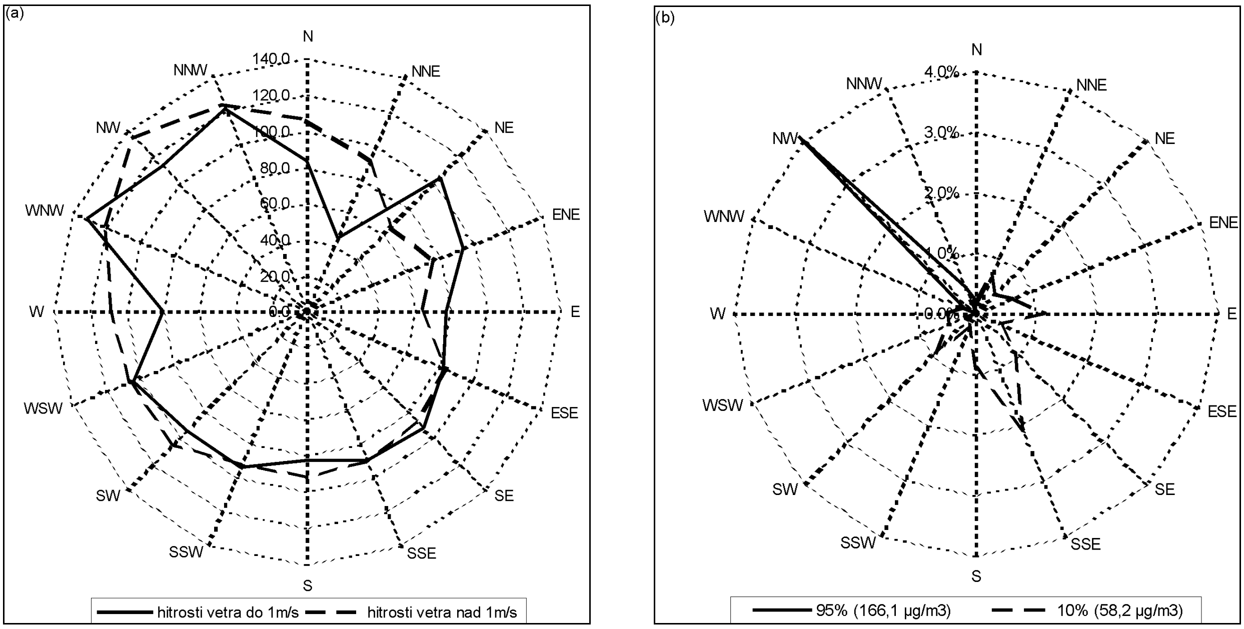
Sl. 3: Povprečne dnevne koncentracije ozona in povprečne dnevne temperature v obdobju od 9. do 25. julija 2007 na (a) merilnem mestu na Markovcu v Kopru, in (b) v Lovranu.
Fig. 3: Average daily concentrations of ozone and average daily temperatures between 9th and 25th July, 2007 at (a) the automatic measuring stations in Koper, Markovec and (b) in Lovran.

meritev pa izkazuje višjo vrednost, 10 percentil vseh koncentracij pa je tista izračunana vrednost iz niza podatkov, od katerih ima 10% meritev nižjo ali enako vrednost, 90% meritev pa višjo vrednost. Podajanje statističnega parametra, kot je percentil, zagotavlja ustrezen prag zanesljivosti oziroma sprejemljivosti podatkov iz serije meritev in primerjavo le-teh na osnovi skupne merske lestvice. Percentilna vrednost se podaja v skladu z Odločbo Sveta EU 97/101/ES o vzajemni izmenjavi informacij in podatkov, pridobljenih prek mreže vzorčevalnih mest in posameznih vzorčevalnih mest, ki merijo onesnaženost zunanjega zraka v državah članicah EU (EC, 1997).

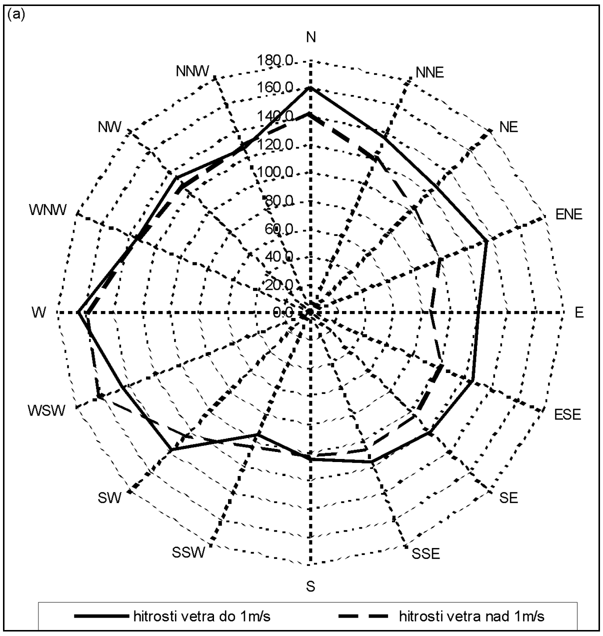
Iz slike 4a vidimo, da se najvišje koncentracije ozona (nad 120 µg/m^3) pojavljajo pri vetrovih hitrosti do 1m/s, ki pihajo iz smeri zahod-severozahod (WNW) in sever-severozahod (NNW), pri vetrovih hitrosti nad 1 m/s pa predvsem iz smeri severozahod (NW). Pri koncentracijah ozona, ki so večje od 95 percentila vseh koncentracij, izmerjenih v merilnem obdobju (koncentracije večje od 166 µg/m^3) (Sl. 4b), je najpogostejši veter iz smeri severozahod (NW), medtem ko je pri koncentracijah, ki so nižje od 10 percentila (koncentracije pod 58 µg/m^3), najpogostejši veter smeri jug-jugozahod (SSE).

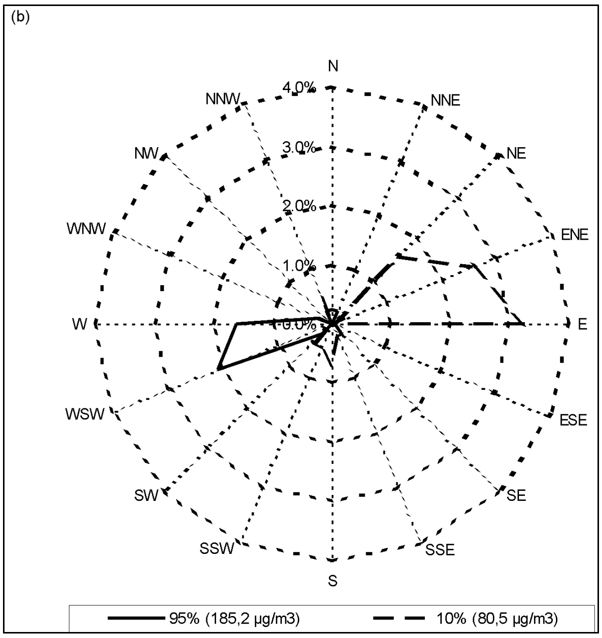
Na sliki 5 so prikazani enaki podatki za mobilno avtomatsko postajo Lovran nad Ankaranom.

Na merilnem mestu Lovran se pri vetrovih, hitrosti do 1 m/s, najvišje koncentracije ozona (nad 150 µg/m^3) pojavljajo ob vetru zahodne (W) in severne smeri (N), pri hitrostih vetra nad 1 m/s pa iz smeri zahod-jugozahod (WSW) in zahodne smeri (W). Za koncentracije ozona, večje od 95 percentila koncentracij (koncentracije nad 185 µg/m^3), je najpogostejši veter iz smeri zahod-jugozahod (WSW) in v manjši meri zahodne smeri (W). Za koncentracije, ki so nižje od 10 percentila (koncentracije pod 80 µg/m^3), pa je najpogostejši veter iz smeri vzhod (E), vzhod-severovzhod (ENE) in severovzhod (NE). Sklepamo, da je razlika v pogostostih in smereh vetra med merilnim mestom na Markovcu v Kopru in Lovranu nad Ankaranom posledica reliefa in topografije. Merilno mesto Lovran je na neizrazitem sedlu na grebenu ankaranskega polotoka. Ta lega nekoliko kanalizira vetrove, kar se kaže v odklonu dejanske smeri. Zaradi tega na merilnem mestu v Lovranu izmerimo drugačne smeri vetra kot na merilnem mestu na Markovcu v Kopru, pri tem pa ima določeno vlogo tudi tako imenovani 'dnevni hod' vetra, ki je na tej lokaciji izrazitejši kot na Markovcu (Planinšek, *osebna komunikacija).* Višje koncentracije ozona na merilnem mestu v Lovranu v primerjavi s koncentracijami, izmerjenimi na Markovcu v Kopru, lahko na tej točki pojasnimo z dejstvom, da so na lokacijah, ki s prometom niso obremenjene, koncentracije ozona praviloma višje, kar smo z našo raziskavo tudi pokazali. Ne glede na razlike v mikrolokaciji in posledično v smereh in hitrostih vetra lahko zaključimo, da se na območju Kopra in Lovrana ter primerljivih lokacijah najvišje koncentracije ozona pojavljajo ob vetrovih (hitrost višja kot 1 m/s) predvsem iz zahodne, severozahodne in jugozahodne smeri.



Sl. 4: (a) Roža onesnaženja (povprečne koncentracije ozona) pri različnih hitrostih vetra in (b) vetrovna roža za dve ravni koncentracij ozona (pogostost smeri vetra), Markovec v Kopru.
Fig. 4: (a) Average concentrations of ozone at different wind speed, and (b) frequency of wind directions for two levels of ozone concentrations, Koper, Markovec.





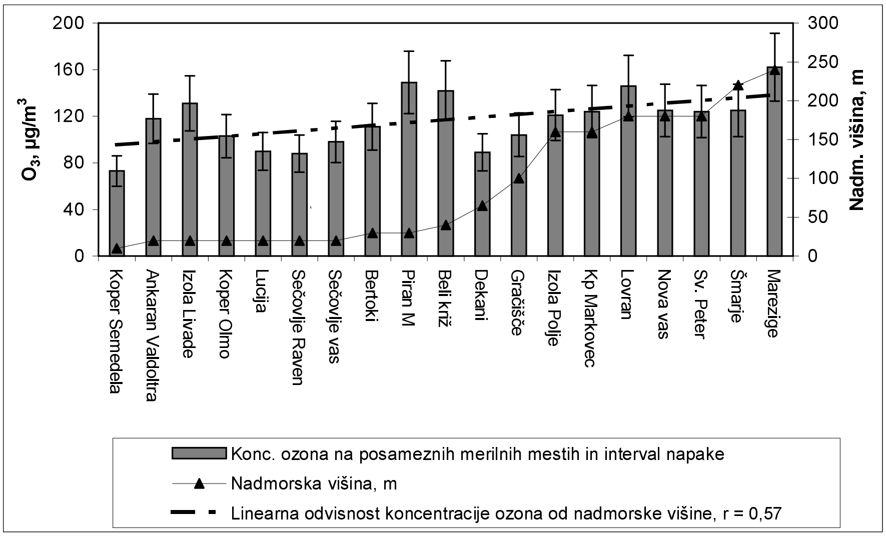
Sl. 5: (a) Roža onesnaženja (povprečne koncentracije ozona) pri različnih hitrostih vetra in (b) vetrovna roža za dve ravni koncentracij ozona (pogostost smeri vetra), Lovran nad Ankaranom.
Fig. 5: (a) Average concentrations of ozone at different wind speeds, and (b) frequency of wind directions for two levels of ozone concentrations, Lovran.

Ocena onesnaženosti zraka z ozonom na širšem območju južne Primorske

Rezultati meritev ozona na izbranih merilnih mestih na območju obalnega dela Slovenije in zaledja so prikazani na sliki 6. Prikazane so koncentracije ozona na izbranih mestih v odvisnosti od nadmorske višine. Skupne koncentracije ozona med 9. in 25. julijem 2007 so znašale med 79 do 179 µg/m^3. Najnižje koncentracije so bile izmerjene v Kopru v Semedeli, Dekanih in Luciji. Na večini drugih merilnih mest so bile izmerjene koncentracije, ki so višje od ciljne vrednosti 120 µg/m^3. Najvišje koncentracije, in sicer med 142 in 179 µg/m^3, so bile izmerjene v Marezigah, Lovranu in v Piranu. Skupne koncentracije, ki so presegle ciljno vrednost 120 µg/m^3, so bile izmerjene še v Livadah v Izoli, na lokaciji Splošne bolnišnice Izola (Polje), na Markovcu v Kopru, v Novi vasi, Sečovljah, Sv. Petru in Šmarjah. V skladu s smernicami WHO (WHO, 2005) naj bi bila za naravno ozadje upoštevana povprečna vrednost ozona 80 µg/m^3, ki ponazarja tako antropogeno kot biogeno emisijo predhodnikov ozona in pri kateri so vplivi na zdravje zanemarljivi. Meritve so pokazale, da je na vseh lokacijah koncentracija, ki opredeljuje naravno ozadje, prekoračena. Na večini merilnih mest je presežena tudi ciljna vrednost, 120 µg/m^3, ki je postavljena zaradi varovanja zdravja ljudi. Na osnovi tega sklepamo, da na lokacijah z izmerjeno skupno koncentracijo ozona višjo od 120 µg/m^3 obstaja možnost potencialne izpostavljenosti ljudi ozonu in s tem tveganja za zdravje, če ta izpostavljenost traja več časa oziroma se ponavlja, kar pa je poleg nekaterih drugih pogojev treba pojasniti z dodatnimi raziskavami.

Glede na meteorološke meritve na avtomatski merilni postaji lahko povzamemo, da se najvišje koncentracije ozona pojavljajo ob zahodnih vetrovih, ki na geografski širini, kjer leži Primorska, prevladujejo v troposferi, in na lokacijah, ki s prometom niso obremenjene. Gre za lokacije na manj onesnaženih ter dobro osončenih legah, merilna mesta z najvišjimi izmerjenimi vrednostmi pa so ob tem tudi više ležeče lokacije z odprtim reliefom in z značilnostmi proste atmosfere (odprto proti morju in zahodnim vetrovom). Obratno so bile najnižje koncentracije ozona izmerjene na niže ležečih merilnih mestih, ki so obremenjena z emisijami iz prometa.

Iz slike 6 lahko tudi povzamemo, da obstaja določena soodvisnost med naraščajočimi koncentracijami ozona in nadmorsko višino. Izračunani korelacijski koeficient (r = 0,57) med koncentracijami ozona in naraščajočo nadmorsko višino potrjuje domnevo, da so koncentracije ozona v više ležečih predelih navadno višje od koncentracij v nižini (Lešnjak *et al.,* 1993; Bizjak *et al.,* 1999; Castel *et al.,* 2008). Iz omenjene literature je razvidno, da gre sicer za nadmorske višine velikostnega razreda 10^3 m in za mesta, ki so večinoma oddaljena od obale, medtem ko gre v naši raziskavi za obalne lege in nadmorske višine reda velikosti 10^2 m. Na osnovi tega lahko sklepamo, da više ležeča, neonesnažena obalna



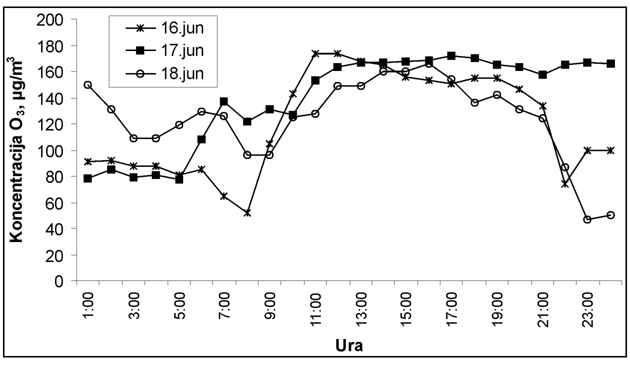
Sl. 6: Skupne koncentracije ozona na izbranih merilnih mestih v obdobju od 9. do 25. julija 2007 v odvisnosti od nadmorske višine, m.
Fig. 6: Cumulative concentrations of ozone at selected sites during the measuring period between 9th and 25th July, 2007, and comparison with altitude, m.

območja južne Primorske izkazujejo glede koncentracij ozona v zraku podobne razmere, kot je to primer iz prej omenjene literature. To je podkrepljeno tudi z ugotovitvijo, da so na niže ležečih območjih, zlasti z emisijami predhodnikov ozona obremenjenih merilnih mestih, koncentracije ozona praviloma nižje.

Nižje koncentracije ozona na mestih, ki so značilna za emisije predhodnikov ozona, na primer dušikovih oksidov iz prometa, so v glavnem posledica reakcije med ozonom in dušikovimi oksidi (NO) oziroma fotolitičnega cikla dušikovega dioksida (NO_2) (Copper & Alley, 1994). Atomarni kisik (O), ki nastane s fotolizo NO_2, je zelo reaktiven in v zraku hitro reagira s kisikom (O_2) v ozon (O_3). V prisotnosti NO pa ozon zaradi svojih oksidativnih lastnosti takoj razpade, pri čemer ponovno nastaneta NO_2 in O_2. Sklepamo, da na lokacijah z značilnimi emisijami dušikovih oksidov (v našem primeru iz prometa) koncentracije ozona niso povišane tudi zaradi omenjenega fotolitičnega cikla NO, v katerem ravno tako ciklično nastaja in razpada tudi ozon. Posledica tega je, da se končna koncentracija ozona v zraku v takih uravnoteženih razmerah ne povišuje. Podobno so ugotovili tudi drugi avtorji (Sillman, 1999; Trainer *et al.,* 2000; Mc Connel *et al.,* 2006).

Ne glede na to je treba omeniti, da je proces lokalno nastalega ozona veliko kompleksnejši in odvisen od različnih dejavnikov (Lelieveld & Dentener, 2000). V fotokemičnem procesu poleg ozona nastajajo tudi drugi produkti, odvisno od ozadja v atmosferi, kot so na primer peroksiacil nitrati (PAN), dušikova kislina, vodikov peroksid, aldehidi, organske kisline, fini delci in vrsta kratko obstojnih radikalov, ki prispevajo k temu, da se ravnotežje osnovne fotolitične reakcije nastanka ozona prevesi v nastanek višjih koncentracij ozona (Cooper & Alley, 1994). K temu lahko bistveno prispevajo specifične meteorološke (in druge) razmere, ki na lokalnem nivoju sprožijo nastanek tako imenovanih ozonskih epizod, kar ponazarja naraščanje koncentracije ozona v zraku oziroma 'kopičenje' ozona v zraku. Pri tem se koncentracija ozona tudi ponoči ne zniža (Sl. 7).

Iz slike 7, ki prikazuje koncentracije ozona na avtomatski merilni postaji na Markovcu v Kopru v različnih dneh junija 2006, je razvidno, da dnevno gibanje koncentracije ozona 16. junija 2006 izkazuje 'normalen' potek nastajanja ozona. Ozon prične nastajati z za

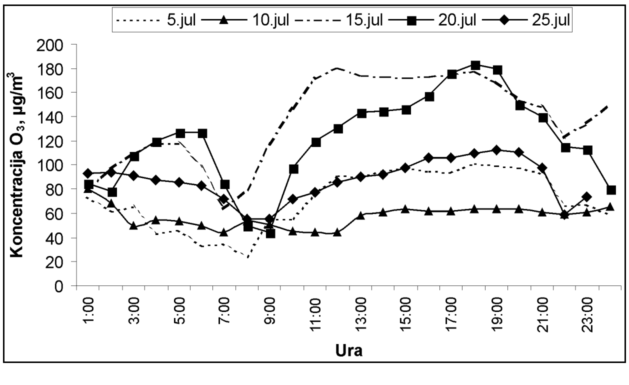


Sl. 7: Primerjava gibanja koncentracij ozona v različnih dneh junija 2006 na avtomatski merilni postaji Koper, Markovec (dnevni hod koncentracij ozona).
Fig. 7: Comparison of concentrations on different days in June 2006 at the automatic measuring station Koper, Markovec (daily profile of ozone concentrations).

četkom sončnega sevanja (izhodiščna koncentracija je odvisna od razmer v prejšnjem dnevu), nato se koncentracija zmanjša, kar se ujema z jutranjo konico povečanega prometa in povečanih emisij predhodnikov ozona, predvsem NO. Sredi dneva koncentracija ozona spet naraste (zmanjšanje emisij iz prometa) in ostane povišana do poznih večernih ur. V nočnem času se koncentracija ozona v zraku v običajnih razmerah ustrezno zmanjša. Ta 'normalni' ciklus je lahko, zaradi prej omenjenih kompleksnih procesov v ozračju, h katerim dodatno prispevajo specifične lokalne meteorološke razmere in razmerja med emisijami predhodnikov ozona, občasno moten. V takih razmerah se koncentracija ozona ponoči ne zmanjša (primer 17. junija 2006) in začne naslednjega dne nastajati pri višji izhodiščni vrednosti (primer 18. junija 2006). V času opravljanja meritev s pasivnimi vzorčevalniki od 9. do 25. julija 2008 take situacije nismo zabeležili (Sl. 8).

V določeni meri vpliva na lokalne koncentracije ozona tudi premikanje zračnih mas v zgornji plasti atmosfere na večje razdalje, ki potencialno prinašajo s seboj onesnažen zrak iz prevladujočih smeri vetra (Derwent, 1990; Žabkar, 2007), transport starejših onesnaženih zračnih mas regionalnega izvora (Bizjak *et al.,* 1999) ter vdor zraka iz proste troposfere oziroma vrivanje ozona iz stratosfere (Sørensen & Nielsen, 2001; Hocking *et al.,* 2007).

Na podlagi ugotovljenega lahko povzamemo, da se na merilnih mestih, zlasti ob obali, ki so primerljiva z lokacijo avtomatske merilne postaje na Markovcu oziroma v Lovranu (Izola Polje, Strunjan, Piran, Beli Križ ter okolica), najvišje koncentracije ozona pojavljajo ob enakih vetrovnih razmerah, torej predvsem ob zahodnih smereh šibkega vetra. Na lokacijah merilnih mest, ki so oddaljena od obale, je zaradi različnega reliefa in topografije pričakovati drugačne smeri in hitrosti vetra, ki



Sl. 8: Primerjava gibanja koncentracij ozona v različnih dneh julija 2007 na avtomatski merilni postaji Koper, Markovec (dnevni hod koncentracij ozona).)
Fig. 8: Comparison of concentrations on different days in July 2007 at the automatic measuring station Koper, Markovec (daily profile of ozone concentrations).

pa v okviru te raziskave, razen na lokaciji Lovran, niso bile izmerjene. Za primerjavo pojavljanja najvišjih koncentracij ozona glede pogostnosti smeri in hitrosti vetra na drugih lokacijah je treba opraviti dodatne meritve.

ZAKLJUČEK

Ocenili smo kakovost zraka zaradi onesnaženosti z ozonom na osnovi pasivnega vzorčenja na posameznih območjih obmorskega dela Slovenije in zaledja. V ta namen smo ovrednotili uporabnost pasivnih vzorčevalnikov za vzpostavitev indikativnih meritev. Primerjali smo dve različni vrsti pasivnih vzorčevalnikov, in sicer vzorčevalnike tipa Radiello, ki so bili analizirani v lastnem laboratoriju, in vzorčevalnike tipa Gradko, ki so bili po končani izpostavitvi analizirani v referenčnem laboratoriju. Medsebojno se rezultati pasivnih meritev z obema vrstama vzorčevalnikov statistično dobro ujemajo, pri čemer je tudi pomembno, da je princip določanja ozona pri obeh vrstah vzorčevalnikov različen.

Rezultate pasivnih meritev smo primerjali tudi s povprečnimi koncentracijami ozona, izmerjenimi na dveh avtomatskih postajah, na Markovcu v Kopru in v Lovranu nad Ankaranom, in statistično dokazali, da se dobro ujemajo. Rezultati validacije metode z uporabo vzorčevalnikov Radiello so pokazali, da je metoda za določitev ozona primerna za opravljanje indikativnih meritev, saj je z zakonodajo opredeljen cilj kakovosti rezultatov, 30% merilne negotovosti meritev, izpolnjen. Metoda je v primerjavi z avtomatskimi meritvami preprosta, stroškovno učinkovita in zanesljiva, izbrani pasivni vzorčevalniki so primerni za spremljanje stanja kakovosti zraka na različnih lokacijah in območjih južne Primorske, kjer avtomatske meritve niso zagotovljene.

S pasivnimi meritvami smo izmerili najnižje skupne koncentracije, okrog 80 $\mu g/m^3$, na merilnih mestih neposredno ob obali in na lokacijah, ki so obremenjene s prometom, na višjih legah pa so bile izmerjene višje koncentracije, med 120 in 180 $\mu g/m^3$, zlasti na legah z značilnostmi proti morju odprte atmosfere. Za te lokacije tudi velja, da niso neposredno obremenjene z emisijami predhodnikov ozona. Na lokalno povišane koncentracije ozona v času tako imenovanih ozonskih epizod vpliva vrsta dejavnikov, od kompleksnih procesov v atmosferi do topografije in drugih značilnosti mikrolokacije in meteorologije, zato z indikativno metodo lahko pridobimo pomembne dodatne podatke o prostorskih razlikah v koncentracijah ozona in njihovi razporeditvi. S sistematičnim merjenjem na večjem številu merilnih mest in v različnih obdobjih, s sočasnim spremljanjem specifičnih meteoroloških razmer (temperatura, hitrost in smer vetra, osončenje...), je mogoče pridobiti tudi podatke, ki so potrebni za pripravo modelnih izračunov, ocenjevanje potencialne izpostavljenosti ljudi in vplivov na živo naravo oziroma rastline, kar je namen prihodnjih meritev in raziskav.

ZAHVALA

Zahvaljujemo se Roku Brincu in Antonu Planinšku iz Agencije Republike Slovenije za okolje za strokovno pomoč pri načrtovanju meritev, izbiri vzorčevalnikov ter za nasvete in pojasnila glede glavnih meteoroloških posebnosti lokacij, na katerih smo opravili meritve. Še posebej hvala Roku Brincu za izbor in obdelavo podatkov avtomatskih meritev in pripravo grafičnih predlog.

ASSESSMENT OF AIR POLLUTION BY OZONE IN THE SLOVENIAN COASTAL REGION BY DIFFUSIVE SAMPLING

Agnes ŠŐMEN JOKSIĆ
Institute of Public Health of Koper, SI-6000 Koper Vojkovo nabrežje 4 a, Slovenia
and
University of Primorska, College of Health Care, SI-6310 Izola Polje 42, Slovenia
E-mail: agnes.somen@zzv-kp.si

Franka CEPAK
Institute of Public Health of Koper, SI-6000 Koper Vojkovo nabrežje 4 a, Slovenia

Smiljana ŠKVARČ
University of Primorska, Primorska Institute of Natural Sciences and Technology, SI-6000 Koper, Muzejski trg 2, Slovenia

SUMMARY

The microenvironment ozone concentrations in the coastal region of Slovenia and inland have been assessed with diffusive samplers. Two different types of diffusive samplers were used for this purpose and results compared to evaluate the method. Cumulative concentrations of ozone were well correlated with average concentrations obtained at reference stationary measuring site. Diffusive samplers appear to be suitable for field use to measure ambient ozone concentration as a part of an indicative air quality monitoring program. The advantages of the method are its simple use and cost-effectiveness in comparison with automatic measuring stations. The sites exposed to elevated traffic showed the lowest levels of ozone, on average 80 μg/m^3. Medium levels were measured in elevated areas with values between 80 and 120 μg/m^3. Highest levels of ozone, between 120 and 180 μg/m^3 were measured in higher, non-polluted areas open to the sea.

Key words: ozone, diffusive samplers, indicative monitoring, air pollution

LITERATURA

Agencija RS za okolje (2007a): Meritve z difuzivnimi vzorčevalniki v letu 2005. ARSO, Ljubljana, 16 str.

Agencija RS za okolje (2007b): Kakovost zraka v R Sloveniji v letu 2006. ARSO, Ljubljana, 106 str.

Agencija RS za okolje (2007c): Program monitoringa kakovosti zunanjega zraka za leto 2008. ARSO, Ljubljana, 55 str.

Barwick, V. J. & S. L. R. Ellison (2000): Development and Harmonisation of Measurement Uncertainty Principles, Part (d): Protocol for Uncertainty Evaluation from Validation Data. VAM Project 3.2.1., Teddington.

Bizjak, M., J. Turšič, M. Lešnjak & T. Cegnar (1999): Air quality monitoring at Mt. Krvavec: Aerosol black carbon and ozone. Acta Chim. Slov., 46(3), 421–434.

Brown, R. H. (1993): The use of diffusive samplers for monitoring of ambient air, Technical Report. International Union of Pure and Applied Chemistry (IUPAC) Pure Appl. Chem., 65(8), 1859–1874, 1993.

Brown, R. H. (2000): Monitoring the ambient environment with diffusive samplers: theory and practical considerations. J. Environ. Monit., 2, 1–9.

Buzica, D., M. Gerboles, L. Amantini & F. Lagler (2005): Laboratory and field inter-comparison of O_3 diffusive samplers. EUR 21754 EN. Office for Official Publications of the European Communities, Luxembourg.

Castel, N., E. Mantilla & M. Millan (2008): Analysis of tropospheric ozone concentration on a western Mediterranean site: Castellon (Spain). Environ. Monit. Assess., 136, 3–11.

Cooper, C. D. & F. C. Alley (1994): Air pollution control: A design approach. 2nd Edition. Waveland Press, Prospect Heights, Illinois.

Derwent, R. G. (1990): The long range transport of ozone within Europe and its control. Environ. Pollut., 63(4), 299–318.

Detimmerman, F., M. Gerboles, L. Amantini & E. De Saeger (2000): Validation of Radiello diffusive sampler for monitoring ozone in ambient air, Report. EUR 19594

EN. Environment Institute, Joint Research Centre, European Commission, 54 p.

EC/97/101 (1997): Council Decision of 27 January 1997 establishing a reciprocal exchange of information and data from networks and individual stations measuring ambient air pollution within the Member States. Official Journal L 035, 05/02/1997, pp. 0014–0022.

EC/2002/3 (2002): Directive 2002/3/EC of the European Parliament and of the Council of 12 February 2002 relating to ozone in ambient air. Official Journal L 67, 09/03/2002.

EEA (1999): Criteria for EUROAIRNET, The EEA Air Quality Monitoring and Information Network. Technical report No.12/1999. EEA, Copenhagen, 56 p.

EEA (2007): Air pollution by ozone in Europe in summer 2006. Technical report No 5/2007. EEA, Copenhagen, 30 p.

EURACHEM (1998): Fitness for Purpose of Analytical Methods, A Laboratory Guide to Method Validation and Related Topics, Edition 0.1.

EURACHEM/CITAC (2000): Guide; Quantifying Uncertainty in Analytical Measurment, Laboratory of the Government Chemist. 2nd Edition. London, UK.

Gerboles, M., D. Buzica, L. Amantini & Lagler F. (2006): Laboratory and field comparison of measurements obtained using the available diffusive samplers for ozone and nitrogen dioxide in ambient air. J. Environ. Monit., 8, 112–119.

Günther, A., C. Geron, T. Pierce, B. Lamb, P. Harley & R. Fall (2000): Natural emissions of non-methane volatile organic compounds, carbon monoxide, and oxides of nitrogen from North America. Atmos. Environ., 34, 2205–2230.

Helaleh, M. I. H., S. Ngudiwaluyo, T. Korenaga & K. Tanaka (2002): Development of passive sampler technique for ozone monitoring. Estimation of indoor and outdoor ozone concentration. Talanta, 58, 649–659.

Hocking, W. K., T. Carey-Smith, D. W. Tarasick, P. S. Argall, K. Strong, Y. Rochon, I. Zawadzki & P. A. Taylor (2007): Detection of stratospheric ozone intrusions by wind-profiler radars. Nature, 450, 281–284.

Koutrakis, P., J. M. Wolfson, A. Bunyaviroch, S. E. Fröhlich, K. Hirano & J. D. Mulik (1993): Measurement of ambient ozone using a nitrate-coated filter. Anal. Chem., 65, 209–214.

Krupa, S., M. Nosal, J. A. Ferdinand, R. E. Stevenson & J. M. Skelly (2003): A multi-variate statistical model integrating passive sampler and meteorology data to predict the frequency distribution of hourly ambient ozone (O_3) concentrations. Environ. Pollut., 124, 173–178.

Lelieveld, J. & F. J. Dentener (2000): What controls troposferic ozone? J. Geoph. Res., 105(D3), 3531–3552.

Lešnjak, M., T. Cegnar, Z. Rajh Alatič & I. Čuhalev (1993): Proc. of EMEP Workshop on the control of photochemical oxidants in Europe. Porvoo, Finland, pp. 122–127.

Liu, L. J. S., P. Koutrakis, H. H. Suh, J. D. Mulik & R. M. Burton (1993): Use of personal measurements for ozone exposure assessment: A pilot study. Environ. Health Persp., 101(4), 318–324.

Liu, L. J. S., R. Delfino & P. Koutrakis (1997): Ozone Exposure Assessment in a Southern California Community. Environ. Health Persp., 105(1), 58–65.

McConnell, R., K. Berhane, L. Yao, F. W. Lurmann, E. Avol & J. M. Peters (2006): Predicting residential ozone deficits from nearby traffic. Sci. Total Environ., 363(1–3), 166–174.

Mohamed, M. F., D. Kang & V. P. Aneja (2002): Volatile organic compounds in some urban locations in United States. Chemosphere, 47, 863–882.

NC DHHS (1999): Risk assessment of ambient ozone concentrations found in North Carolina.

Olcese, L. E. & B. M. Toselli (2006): Recovery of the histogram of hourly ozone distribution from weekly average concentrations. Environ. Pollut., 141, 81–89.

Sather, M. E., J. L. Varns, J. D. Mulik, G. Glen, L. Smith & C. Stallings (2001): Passive ozone network of Dallas: a modeling opportunity with community involvement, 2. Environ. Sci. Technol., 35(22), 4426–4435.

Silman, S. (1999): The relation between ozone, NO_x and hydrocarbons in urban and polluted rural environments. Atmos. Environ., 33(12), 1821–1845.

Sørensen, J. H. & N. W. Nielsen (2001): Intrusion of stratospheric ozone to the free troposphere through tropopause folds – a case study. Phys. Chem. Earth B, 26(10), 801–806.

Trainer, M., D. D. Parrish, P. D. Goldan, J. Roberts & F. C. Fehsenfeld (2000): Review of observation-based analysis of the regional factors influencing ozone concentrations. Atmosph. Environ., 34(12–14), 2045–2061.

Uradni list RS (2003): Uredba o ozonu v zunanjem zraku, Ur.l. RS, 8/2003.

Weschler, C. J., H. Shields & D. V. Naik (1989): Indoor ozone exposures. JAPCA Journal, 39(12), 1562–1568.

Weschler, C. J. (2004): New Directions; Ozone-initiated reaction products indoors may be more harmful than ozone itself. Atmos. Environ., 38, 5715–5716.

WHO (2005): WHO air quality guidelines global update 2005. Report on a working group meeting. EUR/05/5046029. WHO, Copenhagen.

Žabkar, R. (2007): Statistično napovedovanje ozona s predhodnimi razvrščanjem trajektorij v skupine. Končno poročilo o rezultatih študije. FMF, UL in ARSO, Ljubljana.

Original scientific article
Received: 2008-04-12

UDC 591.9:595.35(262.3-17)

FIRST RECORD OF *CHTHAMALUS MONTAGUI* SOUTHWARD, 1976 (CRUSTACEA, CIRRIPEDIA) ON THE SLOVENIAN COAST (GULF OF TRIESTE, NORTHERN ADRIATIC SEA)

Claudio BATTELLI & Nataša DOLENC-ORBANIĆ
University of Primorska, Faculty of Education Koper, SI-6000 Koper, Cankarjeva 5, Slovenia
E-mail: Claudio.Battelli@pef.upr.si

ABSTRACT

The article deals with the mediolittoral chthamalid barnacle Chthamalus montagui *Southward, 1976, not previously noted along the Slovenian coast (Gulf of Trieste, northern Adriatic Sea). The investigation was carried out in the mediolittoral zone during the summer 2007 at 9 sites. Results showed that the main constituents of the sampled chthamalids were* C. montagui *and* C. stellatus *(Poli, 1791) and that* C. montagui *was more abundant. A synoptic table for identification of these two species, based on the external morphological features, is presented.*

Key words: mediolittoral, chthamalid barnacles, *Chthamalus montagui*, *Chthamalus stellatus*, Gulf of Trieste, northern Adriatic Sea

PRIMA SEGNALAZIONE DI *CHTHAMALUS MONTAGUI* SOUTHWARD, 1976 (CROSTACEI, CIRRIPEDI) LUNGO LA COSTA DELLA SLOVENIA (GOLFO DI TRIESTE, ALTO ADRIATICO)

SINTESI

L'articolo tratta la presenza dello Chthamalus montagui *Southward, 1976, una specie appartenente agli ctamalidi del mediolitorale segnalata per la prima volta lungo la costa della Slovenia (Golfo di Trieste, Alto Adriatico). I campionamenti sono stati effettuati in 9 stazioni su substrato duro del mediolitorale nell'estate del 2007. I risultati della ricerca hanno rilevato che i componenti fondamentali degli ctamalidi raccolti sono* C. montagui *e* C. stellatus *(Poli, 1791) e che il più abbondate è* C. montagui. *Viene presentata inoltre una tabella sinottica per l'identificazione di queste due specie, basata sulle caratteristiche morfologiche esterne.*

Parole chiave: mediolitorale, ctamalidi, *Chthamalus montagui*, *Chthamalus stellatus*, Golfo di Trieste, Alto Adriatico

INTRODUCTION

Barnacles are the most abundant and common sessile organisms that live on rocky shores especially in the supralittoral and in the mediolittoral zones throughout the world (Stephenson & Stephenson, 1949; Lewis, 1964; Bellan-Santini *et al.*, 1994). Their biological characteristics and life histories have been well studied by Southward (1987). Barnacles were one of the subjects in Darwin's studies on the Cirripedia (Darwin, 1854). In his works, Darwin described only one species of the genus *Chthamalus*, *Chthamalus stellatus*, with a number of races or varieties. In the Mediterranean, *Chthamalus depressus* (Poli, 1791), which Darwin considered to be a variety of the species *C. stellatus* (Poli, 1791) has been classified as a separate species, recently assigned to the genus *Euraphia* (Newman & Ross, 1976). In 1976, *Chthamalus montagui* Southward, 1976, which was also considered a variety of *C. stellatus*, was identified as a distinct species, due to differences in its vertical zonation on the shore and morphology, particularly in the shape of opercular plates and in setation of the smaller cirri (Southward, 1976).

The main constituents among different species of the mediolittoral chthamalid barnacles belt of the Mediterranean rocky shores, those belonging to the genus *Chthamalus* are *C. montagui* Southward and *C. stellatus* that usually occur together (Pannacciulli & Falautano, 1999; Pannacciulli & Relini, 1999; O'Riordan *et al.*, 2004).

Many works deal with the distribution of barnacles in the Adriatic Sea (Matisz, 1899; Brusina, 1907; Kolosváry, 1947, 1951; Zei, 1955; Zavodnik *et al.*, 1978, 1981). The occurrence of the species *C. stellatus* in the Northern Adriatic Sea (Gulf of Kvarner) has been well known since 1863, when Lorenz (1863) defined it as a guide species of the community – facies *"Patellae et Balaneta"*.

The first occurrence of the species *C. montagui* in the Adriatic Sea was reported by Dando *et al.* (1979), but their studies were restricted to the western coast of the Adriatic. Relini (1981), however, reported on the occurrence of this species from the northern Adriatic (Gulf of Trieste and Rijeka Bay) as well. In the mediolittoral zone of the Gulf of Trieste it has been noted that *C. montagui* is more frequent than *C. stellatus* (Pannacciulli & Relini, 2000).

Recent studies report that there are two species of chthamalids that occur in the mediolittoral zone throughout the Adriatic: *C. stellatus* and *C. montagui* (Zavodnik & Zavodnik, 1994; Zavodnik, 1997, 1998; Zavodnik *et al.*, 2000, 2005, 2006).

Along the Slovenian coast, the chthamalid barnacle species have not been thoroughly studied so far. Information on this group mostly concerns specimens occasionally collected within the frameworks of several environmental studies, where only *C. stellatus* is mentioned for the mediolittoral zone (Lipej *et al.*, 2005).

The aim of the present work was: (a) to investigate the species composition of the mediolittoral chthamalids along the Slovenian rocky shore and (b) to give a general description of the new found species, as well as its basic morphological feature and its habitat. The study was carried out in the summer 2007 at nine sites along the Slovenian coast. The results obtained provide detailed data on the species composition of the mediolittoral chthamalid species, currently unavailable for the considered region.

MATERIALS AND METHODS

Study area

The Slovenian coast covers the southern part of the Gulf of Trieste. The coastline is approximately 46 km long with two main bays, the Bay of Koper and the Bay of Piran, and two smaller bays, the Bay of Izola and the Bay of Strunjan. The coast is composed mainly of Eocene flysch layers (Ogorelec *et al.*, 1997), while in certain areas of Izola the coast is composed of limestone with alveolines and nummulites (Pavlovec, 1985).

The study was restricted to hard, rocky substrata in the mediolittoral of nine sites located along the Slovenian coast (Fig. 1). Sites S1 (Valdoltra: 45°34'51" N, 13°43'20" E) and S2 (Ankaran: 45°34'17" N, 13°44'32" E) are located on the northern side of Koper Bay, which is generally exposed to wave action generated by southwesterly and southeasterly winds. The substratum of the two sites is composed of limestone and sandstone breakwater rocks. Site S3 (Viližan: 45°32'49" N, 13°41'11" E) is situated on the southern part of Koper Bay between Koper and Izola. The shore, which is composed of limestone breakwater rocks, was at that time exposed to wave action and winds blowing in southwest-northeast direction. Site S4 (Izola-Lighthouse: 45°32'32" N, 13°39'42" E) is situated in the

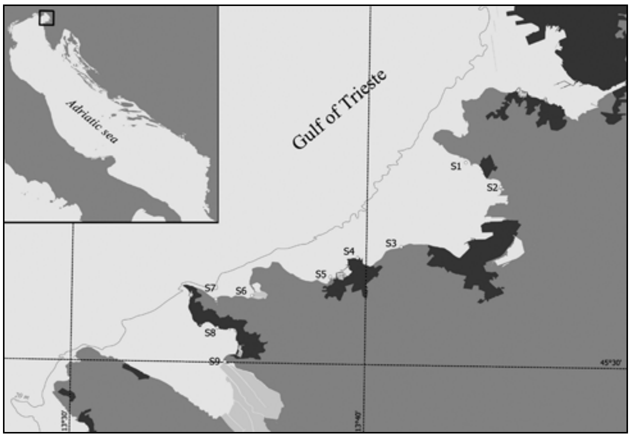


Fig. 1: Map of the investigated area indicating sampling sites.
Sl. 1: Zemljevid raziskovanega območja z vzorčišči.

northern part of Izola, while Site S5 (Simonov zaliv: 45°32'04" N, 13°38'47" E) is located in Simon Bay approximately 500 m away. The substratum of both sites consists of limestone with alveolines and nummulites (Pavlovec, 1985) and is generally of more or less irregular and heteroge-neous structure, with many outcrops and crevices of variable sizes. The wind exposure was northwesterly and northeasterly. Site S6 (Strunjan: 45°31'36" N, 13°36'08" E) is situated in Strunjan Bay along the outer border of the saltpans. It was exposed to wave action and winds blowing mainly from the west; the substrata consisted of limestone breakwater. Site S7 (Fiesa: 45°31'30" N, 13°34'54" E) was located between Strunjan and Piran and was exposed to wave action and winds blowing mainly westwards from northeast. The substrata consisted mainly of solid sandstone. Site S8 (Portorož: 45°30'49" N, 13°34'58" E) is situated in the northern part of the Gulf of Piran on hard substrata composed by limestone. The site was exposed to winds blowing from the south. Site S9 (Seča: 45°30'01" N, 13°35'15" E) is located in the middle of Piran Bay (Seča). The substrata is composed of limestone breakwater rocks and exposed to wave and winds blowing from the west.

Collection and examination of samples

Sampling was carried out in August 2007. At each site, one transect 10 cm wide was randomly selected in the mediolittoral zone, from the upper to the lower limit of the chthamalid barnacles. Only areas, where chthamalids were more abundant and formed homogeneous community along the whole transect, were used. Each transect was scraped clean using a paint scraper and then rinsed with seawater. Samples were preserved in seawater-ethanol (80%) for later study. The collected material is now kept in the laboratory of the Faculty of Education Koper.

Determination and counting of samples took part in the laboratory, with stereo microscope. According to the works of Southward (1976) and Relini (1980), there are many criteria used to distinguish the mediolittoral chthamalid barnacles. But, as suggested by A. J. Southward *(pers. comm.)*, only the external morphological features were used in this study, as follows: (a) shape of the opercular opening, (b) shape of the adductor muscle scar, and (c) position and curvature of the articulation between terga and scuta.

RESULTS AND DISCUSSION

In general, the mediolittoral zone of the investigated sites was dominated by various combinations of barnacles, mussels, limpets, snails, brown, green and red algae. It was dominated by chthamalid barnacles on the one hand, and by dense populations of the macrobenthic algal and faunal communities on the other.

Zonation patterns of the investigated sites

A number of communities occurred in mediolittoral zone of the investigated sites, where three horizons (upper, middle and lower) could be recognized. The upper horizon was occupied by chthamalid communities that formed a belt of 15–20 cm in height. They were associated with various communities of microscopic cyanobacteria (among them *Calothrix* sp. formed very large macroscopic colonies in summer time) and macrobenthic green algae (mainly belonging to the genera *Blidingia*, *Ulva*, *Chaetomorpha* and *Cladophora)*.

Further down, the middle horizon formed a belt of about 60 cm in height (between the mean high water and mean low water). It was occupied by *Chthamalus* species and other faunal species typically found on rocks as gastropods *(Monodonta* sp., *Gibbula* sp.), limpets *(Patella* sp.) and anthozoans *(Actinia equina)*. The most common macrobenthic algae of this horizon were red algae (belonging to the genera *Gelidium* and *Polysiphonia)*. Most abundant among the green algae were

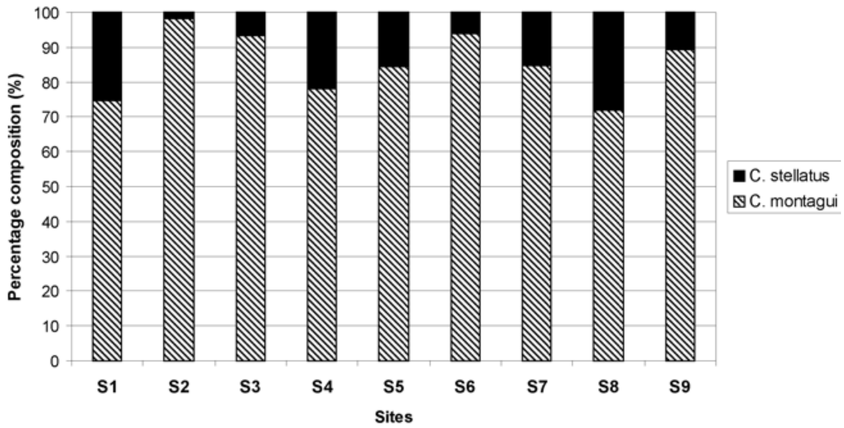


Fig. 2: Percentage composition of** C. stellatus **and** C. montagui **at sampling sites.
Sl. 2: Odstotna sestava vrst** C. stellatus **in** C. montagui **na posameznih vzorčiščih.

Ulva compressa and *Cladophora* sp. The most characteristic alga of this horizon was the brown algae *Fucus virsoides*, which generally occupied the entire horizon.

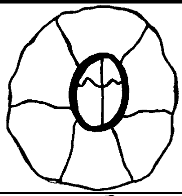
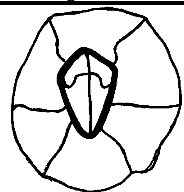
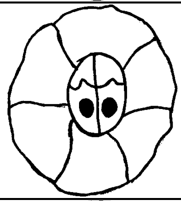
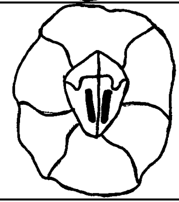
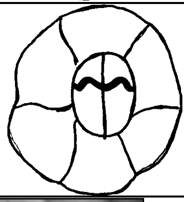
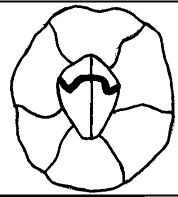
The lower horizon occupied an area of about 15–20 cm in height. It was inhabited mainly by dense aggregates of the bivalve *Mytilus galloprovincialis*. Among macrobenthic algae, it was the green *Ulva laetevirens* that dominated this horizon. Where the surface of the shore was poor in vegetation and fauna, the chthamalids dominated.

Species composition

During the investigation, three chthamalid barnacle species were identified: *Euraphia depressa*, *Chthamalus stellatus* and *C. montagui*. *E. depressa*, characteristic of supralittoral zone, was restricted only to the upper horizon of mediolittoral zone and was very rare, which is the reason why it was not considered in this study. The chthamalid populations were in general more abundant in the upper horizon of the midlittoral. In the middle and in the lower horizons they were rare, but where the surfaces were poorer in vegetation and fauna, the chthamalids prevailed.

The results of the analysis concerning the percentage composition in chthamalid populations showed that two species, *C. montagui* and *C. stellatus*, co-occurred in mediolittoral zone of the sampling sites. Although the percent composition of these two species varied from site to site, *C. montagui* was, in general, significantly more abundant than *C. stellatus* at all investigated sites (Fig. 2).

***Tab. 1: General synoptic table indicating basic external morphological features for identification of** C. stellatus **and** C. montagui.*
***Tab. 1: Preglednica, ki ponazarja temeljne določevalne zunanje morfološke znake vrst** C. stellatus **in** C. montagui.*

Criteria for identification		***Chthamalus stellatus***		***Chthamalus montagui***	
Shape of the opercular opening		Oval or circular		Kite-shaped	
Shape of the adductor muscle pit		Wide, deep and rounded		Long, narrow and close to the occludent margin	
Articulation between terga and scuta	position	One third or more of the opercular opening (from the carina to the rostrum)		Less than one third of the opercular opening (from the carina to the rostrum)	
	curvature	Convex towards rostral plate		Concave towards rostral plate	
Figure					

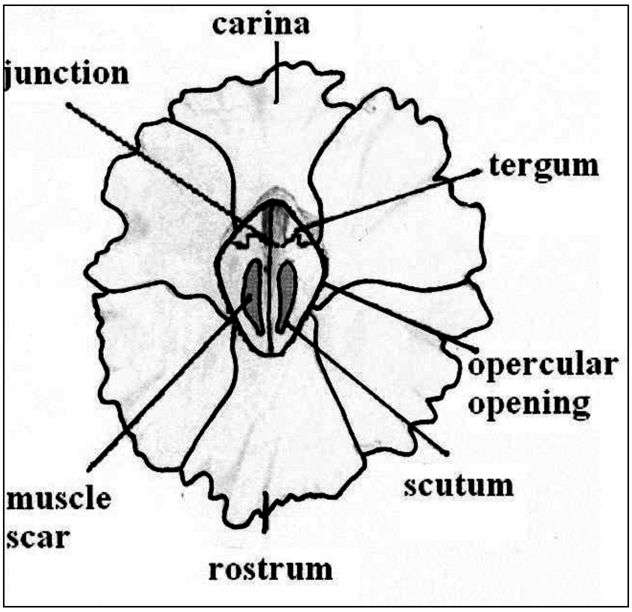


Fig. 3: General structure of** C. montagui **by external features.
Sl. 3: Splošna zgradba vrste** C. montagui **po zunanjih znakih.

Description of *C. montagui*

During the present investigation, the occurrence of *C. montagui* was noted for the very first time along the Slovenian coast. To this end, a brief description of this species, based on the external morphological features, is given (Southward, 1976).

The shell of *C. montagui* is up to 6 mm (max distance from the rostrum to the carina) and is composed of 6 coarsely ridged wall plates (rostrum, carina, 2 rostrolaterals plates and 2 carinolaterals plates). It is often difficult to distinguish the single plates because of corrosion and overgrowth of algae, endolithic and epilithic cyanobacteria and lichens. The shell has a more angular appearance due to the kite-shaped opercular opening. Adductor muscle pits (visible on the scuta) are long, narrow and close to the occludent margin. Articulations between terga and scuta that cross the centre line are quite close to the carina, less than one third the distances to the rostrum. Scuta are longer than wide, while terga are short and wide. The apical angle is usually less than 90° (Fig. 3).

Table 1 illustrates the identification procedure of *C. stellatus* and *C. montagui* based on external morphological features. This investigation indicated that: (a) two chthamalid barnacle species co-occur in mediolittoral zone of the Slovenian rocky shore: *C. montagui* and *C. stellatus*, and (b) that the former was significantly more abundant than the latter. This is in accord with previous studies by Pannacciulli & Relini (2000) for the Italian part of the Gulf of Trieste.

ACKNOWLEDGEMENTS

Our cordial thanks are due to Prof. A. J. Southward for his useful suggestions related to the identification of chthamalid species.

PRVI PODATKI O VRSTI *CHTHAMALUS MONTAGUI* SOUTHWARD, 1976 (CRUSTACEA: CIRRIPEDIA) VZDOLŽ SLOVENSKEGA MORSKEGA OBREŽJA (TRŽAŠKI ZALIV, SEVERNI JADRAN)

Claudio BATTELLI & Nataša DOLENC-ORBANIĆ
Univerza na Primorskem, Pedagoška fakulteta Koper, SI-6000 Koper, Cankarjeva 5, Slovenija
E-mail: Claudio.Battelli@pef.upr.si

POVZETEK

Prispevek obravnava mediolitoralno vrsto rakov vitičnjakov iz rodu Chthamalus, Chthamalus montagui *Southward 1976, ki doslej ni bila znana za slovensko morsko obrežje (Tržaški zaliv, severni Jadran). Raziskava je potekala v poletnem obdobju leta 2007 v mediolitoralu trdne podlage na devetih vzorčiščih vzdolž slovenskega obrežja. Namen raziskave je bil: (a) ugotoviti vrstno sestavo populacij rakov iz rodu* Chthamalus *vzdolž mediolitorala slovenskega morskega obrežja in (b) podati splošni opis nove ugotovljene vrste na temelju zunanjih morfoloških značilnostih ter opisati življenjski prostor te vrste. Raziskava je pokazala, da sta vrsti* C. montagui *in* C. stellatus *Poli, 1791 temeljni komponenti mediolitoralnih združb rakov iz rodu* Chthamalus *in da je vrsta* C. montagui *številčnejša. V prispevku je prikazana tudi splošna preglednica, ki ponazarja temeljne določevalne zunanje morfološke znake obeh vrst.*

Ključne besede: mediolitoral, *Chthamalus montagui*, *Chthamalus stellatus*, Tržaški zaliv, severni Jadran

REFERENCES

Bellan-Santini, D., J. C. Lacaze & C. Poizat (1994): Les Biocénoses marines et littorales de Méditerranée. Synthèse, menaces et perspectives. Museum National d'Histoire Naturelle, Paris, 246 p.

Brusina, S. (1907): Naravoslovne crtice sa sjevero-istočne obale Jadranskog mora, dio četvrti i poslednji. Rad Jugosl. Akad. Zn. Umjet., 171, 42–228.

Dando, P. R., A. J. Southward & D. J. Crisp (1979): Enzyme variation in *Chthamalus stellatus* and *Chthamalus montagui* (Crustacea: Cirripedia): Evidence for the presence of *C. montagui* in the Adriatic. J. Mar. Biol. Ass. U. K., 59, 307–320.

Darwin, C. (1854): A monograph on the sub-class Cirripedia, vol. 2. The Balanidae, the Verrucidae, etc. Ray Society, London.

Kolosváry, G. (1947): Die Balaniden der Adria. Ann. Hist. Nat. Mus. Natl. Hung., 40, 1–88.

Kolosváry, G. (1951): Les Balanides de la Méditerranée. Acta Biol. Acad. Sci. Hung., 2(4), 411–413.

Lewis, J. R. (1964): The Ecology of Rocky Shores. English University Press, London.

Lipej, L., M. Orlando Bonaca & T. Makovec (2005): Raziskovanje biodiverzitete v slovenskem morju. Nacionalni inštitut za biologijo, Morska biološka postaja, Piran, 136 str.

Lorenz, J. R. (1863): Physikalische Verhältnisse und Vertheilung der Organismen im Quarnerischen Golfe. Verl, k. Akad. Wiss., Wien, 379 p.

Matisz, G. (1899): I vertebrati e le forme galleggianti nel Quarnero. Mitt. Naturwiss. Club Fiume, 4, 27–59.

Newman, W. A. & A. Ross (1976): A revision of the balanomorph barnacles; including a catalogue of the species. Mem. S. Diego Soc. Nat. Hist., 9, 1–108.

Ogorelec, B., J. Faganeli, M. Mišič & B. Čermelj (1997): Reconstruction of paleoenvironment in the Bay of Koper (Gulf of Trieste, Northern Adriatic). Annales, Ser. Hist. Nat., 7(1), 187–200.

O'Riordan, R. M., F. Arenas, J. Arrontes, J. J. Castro, T. Cruz, J. Delany, B. Martínez, C. Fernandez, S. J. Hawkins, D. McGrath & A. M. Power (2004): Spatial variation in the recruitment of the intertidal barnacles *Chthamalus montagui* Southward and *Chthamalus stellatus* (Poli) (Crustacea: Cirripedia) over an European scale. J. Exp. Mar. Biol. Ecol., 304, 243–264.

Pannacciulli, F. G. & M. Falautano (1999): Time of larval release in barnacles of the genera *Chthamalus* and *Euraphia* in the Gulf of Genoa (Ligurian Sea) and in the Gulf of Trieste (North Adriatic Sea) – Italy. Biol. Mar. Med., 6(1), 407–410.

Pannacciulli, F. G. & G. Relini (1999): Time of settlement in barnacles of the genus *Chthamalus* in the Gulf of Genoa (Ligurian Sea) and in the Gulf of Trieste (North Adriatic Sea) – Italy. Biol. Mar. Med., 6(1), 411–414.

Pannacciulli, F. G. & G. Relini (2000): The vertical distribution of *Chthamalus montagui* and *Chthamalus stellatus* (Crustacea, Cirripedia) in two areas of the NW Mediterranean Sea. Hydrobiologia, 426, 105–112.

Pavlovec, R. (1985): Numulitine iz apnencev pri Izoli (SW Slovenija). Razprave SAZU, razred IV, 26, 219–230.

Relini, G. (1980): Cirripedi Toracici. Guide per il riconoscimento delle specie animali delle acque lagunari e costiere italiane, 2. Report No. CNR-AQ-1/91. CNR, Roma, 118 p.

Relini, G. (1981): Distribution of *Chthamalus montagui* in the Mediterranean Sea. Rapp. Comm. int. Mer Médit., 27(2), 149–150.

Southward, A. J. (1976): On the taxonomic status and distribution of *Chthamalus stellatus* (Cirripedia) in the northeast Atlantic region: with a key to the common intertidal barnacles of Britain. J. Mar. Biol. Ass. U. K., 56, 1007–1028.

Southward, A. J. (1987): Barnacle biology. Crustacean Issues, 5. AA Balkema, Rotterdam, 443 p.

Stephenson, T. A. & A. Stephenson (1949): The universal feature of zonation between tide-marks on rocky coasts. J. Ecol., 37, 289–305.

Zavodnik, D. (1997): *Chthamalus montagui* and *Platylepas hexastylos*, two cirriped Crustaceans new to the Eastern Adriatic Sea. Nat. Croat., 6(1), 113–118.

Zavodnik, D. (1998): Prilozi morskoj fauni Riječkog zaljeva. 7. Raci brumbuljci (Crustacea: Cirripedia: Balanomorpha). V: Arko-Pijevac, M., M. Kovačić & D. Crnković (ur.): Zbornik prirodoslovna istraživanja riječkog područja. Prirodoslovni muzej Rijeka, Rijeka, pp. 633–637.

Zavodnik, D. & N. Zavodnik (1994): Biološke značajke mora Brseštine. V: Brseč & Brsešćina (ur.). Čakavski sabor, Opatija, 8, pp. 167–178.

Zavodnik, D., N. Zavodnik & Lj. Igić (1978): Bentos Bakarskog zaljeva i problemi zagađivanja. Pomorski zbornik, 16, 419–435.

Zavodnik, D., A. Špan, N. Zavodnik, A. Šimunovič & B. Antolič (1981): Benthos of the western coast of the island Krk (Rijeka Bay, the North Adriatic Sea). Thalassia Jugosl., 17(3–4), 285–337.

Zavodnik, D., A. Jaklin, M. Radošević & N. Zavodnik (2000): Distribution of benthos at Jabuka, an islet of volcanic rock (Adriatic Sea). Period. biol., 102(2), 157–167.

Zavodnik, D., A. Pallaoro, A. Jaklin, M. Kovačić & M. Arko-Pijevac (2005): A benthos of the Senj Archipelago (North Adriatic Sea, Croatia). Acta Adriat., 46, suppl. 2, 3–68.

Zavodnik, D., M. Legac & T. Gluhak (2006): An account of the marine fauna of Pag Island (Adriatic Sea, Croatia). Nat. Croat., 15(3), 65–107.

Zei, M. (1955): Doprinos k ekologiji morskega litorala (s. l.). Supralitoral, litoral in zgornji infralitoral na kamniti zahodnoistrski obali. Razprave SAZU, razred IV, 3, 255–300.

Saggio scientifico originale
Ricevuto: 2007-10-08

UDC 591.553:574.587(282.245.1 Soča)

OSSERVAZIONI SULLE COMUNITÀ MACROZOOBENTONICHE DELL'ISOLA DELLA CONA (FRIULI VENEZIA GIULIA, NORD-EST ITALIA)

Elisabetta PIZZUL & Samuele GUIOTTO
Dipartimento di Biologia, Università degli Studi di Trieste, IT-34127 Trieste, Via L. Giorgieri 10, Italia
E-mail: pizzul@units.it

Giuseppe Adriano MORO
IT-33100 Udine, Via Nardini 18, Italia

SINTESI

In questo studio viene descritta la fauna a Invertebrati bentonici, presente nella zona palustre dell'Isola della Cona, la quale costituisce il nucleo principale terrestre della "Riserva Naturale Regionale della Foce dell'Isonzo". L'analisi qualitativa e quantitativa di queste comunità è stata svolta principalmente per ottenere una prima serie di dati riguardanti questi organismi nel sito, in relazione all'importante ruolo trofico che essi rivestono ed alle scarse notizie riportate sugli stessi in aree costiere sia italiane che estere. La composizione delle comunità di Invertebrati nelle singole stazioni, è tuttavia risultata variare stagionalmente, nell'arco dell'anno di studio, sia da un punto di vista qualitativo che quantitativo; le variazioni osservate vengono messe in relazione con la presenza stagionale dell'avifauna nel sito più che con i parametri abiotici considerati.

Parole chiave: macrozoobenthos, biomassa, area umida costiera, Foce del Fiume Isonzo

OBSERVATIONS ON MACROZOOBENTHIC COMMUNITIES IN THE ISOLA DELLA CONA (FRIULI VENEZIA GIULIA, NORTH EASTERN ITALY)

ABSTRACT

In this study the macrozoobenthic communities of the marsh in the wetland of the Isola della Cona are described. The Isola della Cona is the land core of the "Riserva Naturale Regionale delle Foci dell'Isonzo" (Regional Natural Reserve of Izonzo River Mouth). The qualitative and quantitative analysis of the studied communities was held mainly to obtain data that, despite of the important trophic role of benthic macroinvertebrates, are lacking or scarce for most coastal wetland environments in Italy and other countries. The composition of macrozoobenthic communities varied, as well as the specific biomass, within sampling points during the study period. The seasonality of these variations is supposed to be related to the presence of birds rather than to the considered abiotic parameters.

Key words: macrozoobenthos, biomass, coastal wetland, Isonzo river mouth

INTRODUZIONE

L'isola della Cona, sita in provincia di Gorizia, è in realtà una penisola creata artificialmente dall'uomo mediante deviazione del corso principale del fiume Isonzo nei pressi della sua foce. L'area rappresenta il nucleo principale terrestre della "Riserva Naturale Regionale della Foce dell'Isonzo" (istituita nel 1996), ed è una lingua di terra estesa su una superficie di circa 50 ettari che si sviluppa da Sud-Est a Nord-Ovest circondata dal mare, dallo stesso fiume Isonzo e dal Canale Quarantia (che ha rappresentato la foce principale del fiume nel periodo compreso tra il 1895 ed il 1935). Come riportato da Perco *et al.* (2006) si tratta dell'area umida più settentrionale del Mediterraneo che segna la separazione tra le coste basse tipiche delle Venezie e quelle alte del Carso, Istria e Dalmazia. L'isola della Cona è oggi collegata alla terraferma attraverso una diga che ne consente un agevole accesso. L'interno dell'area, che ora si presenta come una palude, è in realtà il risultato del ripristino dell'ambiente palustre presente prima delle opere di bonifica, che avevano destinato questa area dapprima al pascolo ed in seguito alla coltivazione. Nell'area umida è possibile individuare due zone, poste rispettivamente a monte ed a valle di un edificio adibito ad uso di osservatorio chiamato la Marinetta. La zona a monte è un ambiente prevalentemente dulciacquicolo, è stata bonificata negli anni '30 ed il suo ripristino a palude è stato attuato in due fasi: la prima nel 1984, la seconda tra il 2000 ed il 2001. Quest'area è caratterizzata dalla presenza di vari specchi d'acqua, di dimensioni contenute e con profondità sempre inferiori ad un metro, generalmente comprese tra i dieci ed i quaranta centimetri.

La zona posta a valle dell'osservatorio sopra citato è, invece, rimasta paludosa fino al 1983 quando è stata arginata, parzialmente arata e dotata di scoline, ma non è stata mai coltivata. Il ripristino dell'ambiente palustre è stato svolto, in questo caso, nel 1989. Questa area, con caratteristiche salmastre, è costituita da pochi specchi d'acqua che, a parte quelli posti nelle zone più a monte, sono ampi ed uniformi, lentamente digradanti dalle zone di acqua bassa alla parte centrale più profonda.

Entrambe le zone in cui è divisa la palude sono ancora dotate di scoline, residuo dell'opera di bonifica. Sono stati inoltre realizzati un canale centrale ad andamento non rettilineo e varie "isole" mai sommerse, allo scopo di aumentare la diversità ambientale, la biodiversità ed il valore estetico della riserva. Particolare attenzione è stato rivolta alle popolazioni aviarie, cercando di incrementare il numero di specie, dando alla zona un elevato valore paesaggistico e favorendo l'accesso alle postazioni di osservazione da parte sia del personale che dei turisti/appassionati di bird watching, senza che questi arrechino eccessivo disturbo alle popolazioni (F. Perco, *inf. pers.).*

La gestione della Riserva consiste prevalentemente nel controllo dei livelli dell'acqua e della vegetazione emergente ed emersa sulla superficie dell'area. La regolazione del livello dell'acqua, attuata artificialmente da personale della Riserva per motivi sia ecologici che sanitari, è importante in quanto in grado di controllare molti parametri dell'ecosistema. Il periodico prosciugamento, quasi totale, dell'area (generalmente attuato in agosto) ha, ad esempio, un importante effetto nel controllo sia qualitativo che quantitativo della vegetazione (van der Valk, 1990). La condizione di secca provoca la morte di alghe e piante strettamente acquatiche, con conseguente rapida germinazione di varie specie vegetali pioniere sulla superficie fangosa, presto asciutta. Alcuni semi di piante acquatiche e semiacquatiche necessitano infatti di un periodo di secco per poter germinare. Il prosciugamento permette, inoltre, una completa mineralizzazione dei nutrienti organici presenti nel substrato, rendendoli così nuovamente disponibili ed evitando condizioni di ipossia o anossia. Inoltre, in alcuni periodi, la presenza di prati è importante per favorire la sosta di alcune specie di uccelli. Il controllo dei livelli dell'acqua ha poi pesanti ripercussioni sulla biomassa e sulla biodiversità dei macroinvertebrati acquatici, in quanto favorisce la presenza di specie con larve a sviluppo univoltino o multivoltino. Le forti fluttuazioni dei livelli d'acqua, invece, provocano una sporadica presenza di specie che sono intolleranti nei confronti di lunghe emersioni o di lunghi periodi con alte temperature e basse concentrazioni di ossigeno disciolto, caratteristiche tipiche delle pozze presenti durante i periodici prosciugamenti.

Le conseguenze, appena descritte, del controllo dei livelli dell'acqua sono state registrate anche nella riserva inglese ARC Wildfowl Riserve, come riportato da Street (1982).

Per quanto concerne il controllo dello sviluppo della vegetazione, nella Riserva Naturale dell'Isola della Cona i metodi utilizzati sono sia strumenti meccanici sia il pascolamento di gruppi di cavalli di razza Camargue. L'uso dei cavalli, nonostante il rischio del trampling (calpestamento dei pulcini e dei nidi), è stato adottato dopo aver constatato la loro capacità nel controllo dello sviluppo della flora acquatica nel Parco Naturale Regionale di Camargue alla foce del fiume Rodano (Duncan & D'Herbes, 1982).

La gestione della Riserva ha infine previsto l'eliminazione, nell'area umida dell'Isola della Cona, della fauna ittica, la quale è stata relegata in pochi stagni profondi e perenni. La scelta è stata dettata dall'analisi dei risultati ottenuti da un esperimento svolto in due laghi presso l'ARC Wetlands Research Centre in Gran Bretagna, da Giles (1990). L'Autore riporta un rilevante aumento della biomassa di invertebrati, in particolare di ditteri chironomidi, in un bacino da cui precedentemente sono stati prelevati i pesci presenti, i quali

risultavano in competizione alimentare con gli uccelli acquatici insettivori. Lo stesso autore rileva che l'eliminazione dei pesci determina, inoltre, l'aumento della biomassa vegetale, fatto che favorisce la presenza di uccelli fitofagi.

Studi riguardanti gli Invertebrati presenti negli stagni della Riserva, sono stati condotti nel 1992/93 da Stoch (1995), su coleotteri e crostacei. Da questi studi è emerso che gli stagni sia d'acqua dolce che salmastra presentano in questo sito un'elevatissima biodiversità e che all'interno dei gruppi analizzati vi sono specie precedentemente mai segnalate in Italia o nell'intero bacino Mediterraneo. Stoch (1995) segnala la presenza di 46 specie di coleotteri acquatici o ripariali e 72 specie di crostacei, benché secondo l'autore le specie in realtà presenti nell'arco dell'anno potrebbero, per entrambe i gruppi, essere molte di più. Per quanto concerne i coleotteri di particolare interesse è il rinvenimento di una popolazione numerosa di *Cybister lateralimarginalis*, specie che dall'inizio del '900 non veniva più segnalata in regione, e che essendo un predatore testimonia la presenza di comunità ben strutturate. Anche per i crostacei vi sono segnalazioni interessanti nella Riserva: tre specie nuove per l'Italia, quattro specie nuove per il Friuli Venezia Giulia e 11 specie che nel bacino del Mediterraneo o in Italia o nel Friuli Venezia Giulia sono segnalate solo all'Isola della Cona (Stoch, 1999a, 1999b, 2000).

Il presente studio non è uno studio tassonomico, la sua finalità è principalmente quella di descrivere la struttura delle comunità macrozoobentoniche presenti nell'area umida della riserva e soprattutto di fornire delle stime riguardanti la biomassa di questi organismi, ciò per l'importante ruolo trofico che questi organismi assumo, in qualità di prede per molti uccelli che stazionano più o meno stabilmente nel sito.

MATERIALI E METODI

I campionamenti quantitativi della fauna macrozoobentonica sono stati condotti in entrambe le zone (zona a monte e zona a valle rispetto all'osservatorio la Marinetta) in cui la palude dell'Isola della Cona viene distinta. Le due zone sono state denominate M (zona a monte l'osservatorio) e V (zona a valle l'osservatorio) e le stazioni di campionamento sono state indicate con la lettera della zona in cui sono posizionate ed un numero. Le stazioni complessivamente individuate sono state 18 nella zona M e 7 nella zona V ed in esse sono state compiute tre campagne di campionamento, rispettivamente nel luglio 2001, marzo 2002 e nel luglio 2002 (Fig. 1).

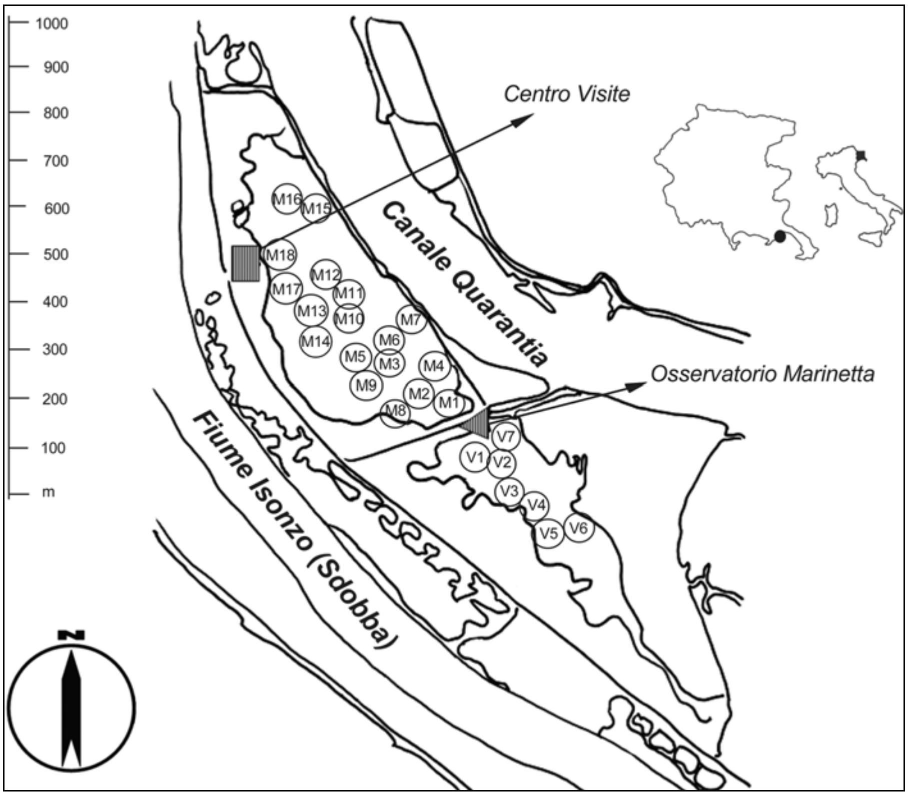


Fig. 1: Area di studio con indicate le stazioni di campionamento (Perco* et al.*, 2006; con modifiche).
Sl. 1: Preučevano območje z vzorčišči (Perco* et al.*, 2006; modificirano).

La raccolta dei campioni è stata effettuata utilizzando il metodo "con tubo di stufa" (Campaioli *et al.*, 1994). Il campione è stato pertanto ottenuto utilizzando un tubo di ferro della lunghezza pari a 60 cm e diametro di 12 cm. Sono stati eseguiti cinque prelievi per ogni stazione, per un totale di 0,22 m^2.

Le carote di ogni campione e la colonna d'acqua loro soprastante, sono state setacciate sul posto con un setaccio a maglie di 1mm. Successivamente i campioni sono stati sottoposti ad un lavaggio più accurato (sempre utilizzando una rete con maglie di 1 mm per trattenere i macroinvertebrati presenti) allo scopo di eliminare la maggior parte dell'inerte. I campioni sono stati quindi fissati in formalina al 4% tamponata con bicarbonato di sodio. In laboratorio è stato condotto il sorting di ogni singolo campione, mediante analisi al microscopio binoculare (ingrandimenti variabili da 4x a 40x). Gli Invertebrati raccolti sono stati posti in provette Eppendorf e conservati in alcool al 70%. Successivamente gli organismi presenti in ciascun campione sono stati determinati e contati. La determinazione è stata, generalmente, condotta fino a livello di famiglia o genere, in alcuni casi fino alla specie, utilizzando le chiavi dicotomiche di: Olmi, 1978; Argano, 1979; Tamanini, 1979; Girod *et al.*, 1980; Mc Kenzie & Ghetti, 1981; Pirisinu, 1981; Rossaro, 1982; Margaritora, 1983; Nocentini, 1985; Campaioli *et al.* 1994, 1999.

I singoli taxa sono stati tenuti in provette Eppendorf contenenti alcool al 70%. Dopo aver determinato il numero di organismi, appartenenti ad ogni taxon, questi sono stati essiccati e quindi inceneriti, per determinare il peso secco e delle ceneri. I valori di biomassa riportati si riferiscono alla differenza tra il peso secco ed il peso delle ceneri. L'essiccazione è stata fatta in stufa a 105°C per 14 ore. Questa operazione è stata preceduta dalla taratura dei crogioli atti a contenere gli Invertebrati, che è stata eseguita tramite un trattamento termico in stufa a 105°C per 6 ore e pesatura su bilancia analitica. L'incenerimento è stato eseguito in muffola a 550°C per 7 ore. La differenza tra il peso secco ed il peso delle ceneri così ottenuti ha permesso di stimare la biomassa di ogni esemplare raccolto, dato questo necessario per la determinazione delle biomasse specifiche (espresse in g/m^2) nelle singole stazioni.

In contemporanea con le operazioni di campionamento, utilizzando strumenti della Hanna Instruments, sono stati rilevati i seguenti parametri chimico fisici relativi ad ogni stazione: pH e temperatura mediante pH metro modello HI 8314, (pH ± 0,1 unità e temperatura ± 0,1°C); conducibilità tramite conduttivimetro HI DIST WP3 (± 1 mS/cm). Detti parametri, rilevati da Personale dell'Isola della Cona, sono stati registrati nel corso del secondo e terzo campionamento (marzo e luglio 2002). Dai valori di conducibilità è stata, in seguito, ricavata la salinità come concentrazione molare di NaCl.

RISULTATI

Parametri chimici e fisici

I valori di temperatura, pH e concentrazione di NaCl misurati nelle zone M e V nel mese di marzo e luglio 2002 sono riportati in Tabella 1. I valori misurati nel punto M04 sono riportati separatamente poiché in esso la concentrazione di NaCl è nettamente superiore a quella registrata negli altri punti della zona M.

Sono stati quindi condotti dei confronti fra i valori medi dei diversi parametri studiati utilizzando il test *t*, supponendo una distribuzione normale della variabile e considerando significativi i valori di $p \leq 0{,}05$.

La differenza fra la concentrazione media di NaCl nella zona M (escluso il punto M04) ed in quella V, é risultata significativa sia a marzo che a luglio ($p < 0{,}0001$ e $p = 0{,}0001$). La differenza fra i valori di temperatura dell'acqua e quelli di pH fra le due zone non è, invece, mai risultata significativa ($p > 0{,}05$).

Tab. 1: Valori di temperatura, pH e concentrazione di NaCl misurati nelle due zone su due periodi di campionamento.
Tab. 1: Vrednosti temperature, pH in koncentracij NaCl, izmerjene v dveh conah med dvema obdobjema vzorčevanja.

	Marzo 2002				
	Zona M		**Punto M04**	**Zona V**	
	media	dev. st.		media	dev. st.
T (°C)	11,9	1,49	11,8	11,68	1,28
pH	8,51	0,50	7,49	8,26	0,07
NaCl (mol/l)	0,00510	0,00222	0,25100	0,01104	0,00159
	Luglio 2002				
	Zona M		**Punto M04**	**Zona V**	
	media	dev. st.		media	dev. st.
T (°C)	25,8	2,01	26,5	21,0	1,25
pH	7,76	0,34	7,44	7,48	0,16
NaCl (mol/l)	0,00670	0,0035	0,07405	0,01496	0,00533

La differenza di concentrazione media di NaCl fra le due stagioni nell'ambito di una stessa zona é risultata significativa solo per la zona V (p = 0,0066). Le variazioni di temperatura fra le due stagioni sono risultate superiori a 10°C. Le variazioni stagionali di pH non sono significative (p >0,05). I valori di concentrazione di NaCl misurati nel punto M04 sono sempre stati quelli più elevati nell'ambito dell'area di studio.

Biomassa dei macroinvertebrati

Gli organismi raccolti appartenevano ai Phyla degli Arthropoda, Mollusca e Anellida. Gli Arthropoda erano gli organismi più rappresentati nei campioni. La Classe più abbondante era quella degli Insecta, rappresentata da 4 Ordini: Hemiptera, Diptera, Coleoptera, Odonata (Allegati 1–6).

I valori di biomassa specifica (g/m^2) stimati in ciascuna delle due zone (Tab. 2) variano da un minimo di 0,016 g/m^2 ad un massimo di 9,468 g/m^2. Come si può osservare generalmente il valore medio di biomassa specifica è risultato superiore nella zona M rispetto a quello stimato per la zona V, le differenze rinvenute, tuttavia, non sono risultate statisticamente significative (p >0,05).

Nell'ambito della zona M le variazioni stagionali dei valori di biomassa specifica media (Fig. 2) sono maggiori rispetto alla zona V (Fig. 3). Tuttavia solo nella zona M e solo per il confronto fra il mese di marzo 2002 e quello di luglio 2002 la differenza di biomassa specifica media é risultata significativa dal punto di vista statistico (p = 0,01480).

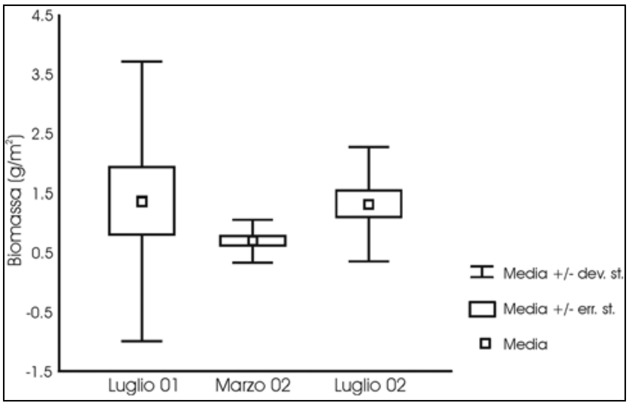


Fig. 2: Biomassa specifica media nella zona M per ogni campagna di campionamento (18 punti).
Sl. 2: Povprečna specifična biomasa, ocenjena za cono M v vsakem posameznem obdobju vzorčevanja (18 točk).

Nelle campagne di luglio 2001 e marzo 2002 alcuni campioni sono risultati completamente privi di fauna acquatica. In un caso (il punto M6 nel luglio 2001) erano presenti soltanto pochi esemplari di coleotteri terrestri. E' verosimile che questi campioni siano stati raccolti in punti dove il fondo era emerso fino a poco tempo prima il campionamento. Risulterebbe altresì inspiegabile l'assenza di macroinvertebrati bentonici che, in tutti gli altri campioni, sono sempre presenti.

Il maggior contributo in termini di biomassa nei campioni esaminati (Tab. 3, 4) viene fornito dai Mollusca Gastropoda, Anellida Polychaeta, Hemiptera Heteroptera, Coleoptera e Diptera. I taxa più abbondanti (in termini di biomassa) risultano essere, generalmente, i Diptera ed i Coleoptera, ad eccezione del campionamento di luglio 2001, quando il maggior contributo alla biomassa totale dei campioni venne fornito dai Mollusca Gastropoda nella zona M e dagli Anellida Polychaeta nella zona V. La variazione del contributo relativo dei singoli gruppi appare rilevante in diversi casi. I Mollusca Gastropoda nell'ambito della zona M, per esempio, passano dal 52,3% della biomassa totale nel luglio 2001 ad appena l'1,2% della biomassa del mese di marzo 2002, quindi il loro contributo relativo torna ad aumentare a 28,7% della biomassa totale nel luglio 2002 (Tab. 4). Gli stessi Gastropoda nella zona M forniscono un contributo alla biomassa totale sempre inferiore al 4%. Tale variazione relativa corrisponde a quella del valore di biomassa media specifica (Tab. 3).

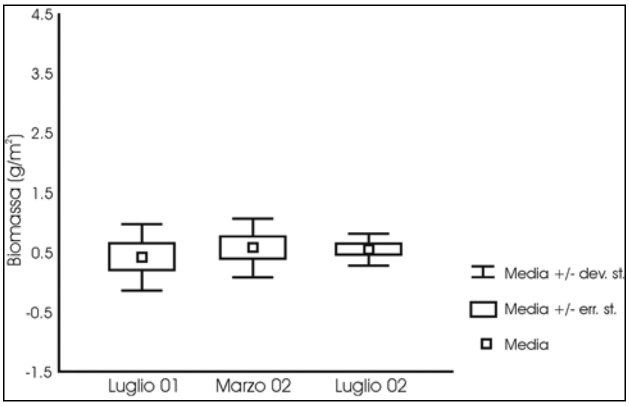


Fig. 3: Biomassa specifica media nella zona V per ogni campagna di campionamento (7 punti).
Sl. 3: Povprečna specifična biomasa, ocenjena za cono V v vsakem posameznem obdobju vzorčevanja (7 točk).

Analoghe variazioni riguardano i Diptera il cui contributo alla biomassa totale varia fortemente, sia in termini assoluti che relativi, con valori più elevati nel marzo del 2002 (54,2% della biomassa in zona M, 88,6% in zona V) rispetto agli altri due campionamenti (Tab. 3, 4).

É interessante osservare che la biomassa di Diptera ed Oligochaeta è massima nel mese di marzo, quando gli altri taxa presentano un minimo. I valori di biomassa specifica media (g/m^2) stimati per i Diptera e gli Oligo-

Tab. 2: Biomasse medie specifiche (g/m²) per le due zone nei tre periodi di campionamento.
Tab. 2: Povprečna specifična biomasa (g/m²) dveh con med tremi obdobji vzorčevanja.

	Luglio 2001		Marzo 2002		Luglio 2002	
	M	V	M	V	M	V
max	9,468	1,506	1,246	1,188	3,157	1,010
min	0,028	0,030	0,058	0,016	0,028	0,168
media	1,365	0,428	0,691	0,571	1,313	0,544
dev. st.	2,355	0,556	0,361	0,513	0,962	0,289

Tab. 3: Abbondanza dei principali taxa in termini di biomassa media specifica (g/m²) nelle due zone ed in stagioni diverse.
Tab. 3: Številčnost glavnih taksonov glede na splošno specifično biomaso (g/m²) v dveh conah med različnimi obdobji.

	Luglio 2001		Marzo 2002		Luglio 2002	
	M	V	M	V	M	V
Gastropoda	0,714	0,000	0,008	0,012	0,377	0,018
Polychaeta	0,129	0,355	0,028	0,000	0,001	0,002
Oligochaeta	0,102	0,000	0,130	0,008	0,090	0,001
Crustacea	0,007	0,016	0,008	0,007	0,002	0,016
Odonata	0,115	0,000	0,001	0,000	0,068	0,036
Hemiptera	0,014	0,022	0,019	0,010	0,084	0,116
Coleoptera	0,204	0,026	0,123	0,028	0,535	0,197
Diptera	0,080	0,010	0,375	0,506	0,157	0,159

chaeta nel mese di marzo sono risultati significativamente maggiori rispetto a quelli stimati per i mesi di luglio 2001 e luglio 2002 ($p < 0,05$). Sebbene fra i Diptera e gli Oligochaeta siano presenti organismi con caratteristiche ecologiche differenti, questi animali sono generalmente detritivori. Questa elevata presenza di detritivori nel mese di marzo segue il periodo di massima presenza, nell'ambito degli specchi d'acqua studiati, dell'avifauna svernante (Perco *et al.*, 2006).

DISCUSSIONE E CONCLUSIONI

I risultati delle indagini svolte hanno messo in evidenza la variabilità dei valori di biomassa specifica nell'ambito delle zone allagate studiate. Tale variabilità é notevole nella zona denominata M, mentre appare più limitata nella zona denominata V. La separazione delle due zone, garantita dalla presenza di un argine in terra, e la diversa morfologia dei bacini allagati, suggerirebbe l'instaurarsi di condizioni ambientali differenti. Fra i parametri presi in considerazione l'unico che é significativamente diverso fra le due zone é la salinità, intesa come concentrazione di NaCl. La salinità non sembra essere in ogni caso un fattore sufficiente a spiegare la differenza notevole fra i due range dei valori di biomassa misurati nel mese di luglio del 2001 nelle diverse zone. La variabilità notevole di questi valori registrata nella zona M non corrisponde ad una pari variabilità nei valori della salinità, così come degli altri due parametri misurati (temperatura e pH). E' stato peraltro verificato che non vi é alcuna correlazione significativa fra la salinità ed i valori di biomassa rilevati, sia nella zona M che in quella V. L'ipotesi di una correlazione fra i valori di biomassa e la distanza dell'area campionata dal margine della zona allagata é risultata allo stesso modo non supportata dalle osservazioni effettuate e, sebbene nella zona M sia intuibile un gradiente dei valori di biomassa apparentemente legato alla distanza dall'argine che separa il bacino dal canale della Quarantia, l'analisi statistica dei dati non consente di considerare significativa una correlazione fra le due variabili.

In complesso da questo studio emerge la possibilità di considerare piuttosto uniforme, per quanto riguarda i valori di biomassa, ognuna delle due zona. E' probabile che la variabilità nei valori di biomassa misurati nel mese di luglio 2001 nella zona M sia dovuta a variazioni nella disponibilità di risorse trofiche, come depositi di detrito organico o concentrazioni di alghe bentoniche. In generale, comunque, la modesta profondità dei bacini studiati é tale da consentire assai verosimilmente un continuo rimescolamento e la redistribuzione uniforme dei detriti fini.

Tab. 4: Abbodanza relativa (%) dei principali taxa in termini di biomassa nelle due zone ed in stagioni diverse.
Tab. 4: Relativna številčnost (%) glavnih taksonov glede na biomaso v dveh conah med različnimi obdobji.

	Luglio 2001		Marzo 2002		Luglio 2002	
	M	V	M	V	M	V
Gastropoda	52,3	0,0	1,2	2,2	28,7	3,4
Polychaeta	9,5	82,8	4,1	0,0	0,1	0,4
Oligochaeta	7,4	0,0	18,8	1,4	6,9	0,1
Crustacea	0,5	3,7	1,2	1,2	0,2	2,9
Odonata	8,4	0,0	0,1	0,0	5,2	6,6
Hemiptera	1,1	5,0	2,7	1,7	6,4	21,3
Coleoptera	15,0	6,2	17,7	4,8	40,7	36,2
Diptera	5,8	2,3	54,2	88,6	11,9	29,2

Il contributo alla biomassa totale fornito da organismi a rapido sviluppo, come i Diptera e gli Oligochaeta, è risultato essere rilevante nella fase primaverile, mentre la sua importanza diminuisce nel corso dell'estate, quando organismi a crescita più lenta e turnover minore prevalgono (Gastropoda e Coleoptera). È probabile che tali variazioni siano profondamente legate alla estrema variabilità annuale di parametri quali la temperatura dell'acqua e la produzione primaria, ma è ragionevole ritenere che la disponibilità di materiale organico, in larga misura dipendente dalle deiezioni dell'avifauna svernante, sia il fattore più importante per spiegare le variazioni stagionali osservate.

Ulteriori approfondimenti degli studi sull'ecosistema acquatico dell'Isola della Cona dovrebbero rivolgersi ad una più chiara comprensione della rete trofica in cui si inseriscono i macroinvertebrati bentonici, con particolare riguardo allo studio del trasferimento di carbonio, nutrienti ed energia all'interno degli specchi d'acqua e fra questi e gli ambienti confinanti.

RINGRAZIAMENTI

Si ringrazia il Dott. Fabio Perco e lo staff dell'Isola della Cona, il dott. Fabio Stoch ed il Dott. Stefano Sponza.

MAKROZOOBENTOŠKE ZDRUŽBE, UGOTOVLJENE NA MOKRIŠČU ISOLA DELLA CONA (FURLANIJA – JULIJSKA KRAJINA, SEVEROVZHODNA ITALIJA)

Elisabetta PIZZUL & Samuele GUIOTTO
Dipartimento di Biologia, Università degli Studi di Trieste, IT-34127 Trieste, Via L. Giorgieri 10, Italija
E-mail: pizzul@units.it

Giuseppe Adriano MORO
IT-33100 Udine, Via Nardini 18, Italija

POVZETEK

V prispevku so opisane makrozoobentoške združbe, ugotovljene na mokrišču Isola della Cona, ki oblikuje kopensko jedro Regionalnega naravnega rezervata v ustju reke Soče. Kvalitativna in kvantitativna analiza preučevanih združb sta bili opravljeni predvsem z namenom, da se zagotovijo podatki, ki jih kljub pomembni trofični vlogi bentoških makronevretenčarjev ni ali pa so zelo redki za večino obalnih mokrišč v Italiji in drugih državah. Sestava makrozoobentoških združb se je tako kot tudi njihova specifična biomasa z vzorčišči močno spreminjala med preučevanim obdobjem. Sezonskost teh sprememb naj bi bila bolj povezana s pojavljanjem ptic v tem območju kot pa s preučenimi abiotskimi parametri.

Ključne besede: makrozoobentos, biomasa, obalna mokrišča, ustje reke Soče

BIBLIOGRAFIA

Argano, R. (1979): Isopodi (Crustacea: Isopoda). Guide per il riconoscimento delle specie animali delle acque interne italiane. C.N.R. AQ/1/43, 5, pp. 1–63.

Campaioli, S., P. F. Ghetti, A. Minelli & S. Ruffo (1994): Manuale per il riconoscimento dei macroinvertebrati delle acque dolci italiane. Provincia Autonoma di Trento, I, pp. 1–356.

Campaioli, S., P. F. Ghetti, A. Minelli & S. Ruffo (1999): Manuale per il riconoscimento dei macroinvertebrati delle acque dolci italiane. Provincia Autonoma di Trento, II, pp. 357–484.

Duncan, P. & J. M. D'Herbes (1982): The use of domestic herbivores in the management of wetland for waterbirds in the Camargue, France. Managing Wetlands and Their Birds. International Waterfowl Research Bureau, pp. 51–66.

Giles, N. (1990): Fish-removal from lakes increases food for waterfowl. Wetland Management and Restoration. Swedish environmental protection agency, pp. 80–86.

Girod, A., I. Bianchi & M. Mauro (1980): Gasteropodi, 1 (Gastropoda: Pulmonata; Prosobranchia: Neritidae, Viviparidae, Bithynidae, Valvatidae). Guide per il riconoscimento delle specie animali delle acque interne italiane. C.N.R. AQ/1/44,7, pp. 1–86.

Margaritora, F. (1983): Cladoceri (Crustacea: Cladocera). Guide per il riconoscimento delle specie animali delle acque interne italiane. C.N.R. AQ/1/197, 22, pp. 1–169.

Mc Kenzie, K. & P. F. Ghetti (1981): Ostracodi (Crustacea: Ostracoda). Guide per il riconoscimento delle specie animali delle acque interne italiane. C.N.R. AQ/1/108, 11, pp. 1–82.

Nocentini, A. (1985): Chironomidi, 4 (Diptera Chironomidae: Chironominae, larve di). Guide per il riconoscimento delle specie animali delle acque interne italiane. C.N.R. AQ/1/233, 29, pp. 1–186.

Olmi, M. (1978): Driopidi, Elmintidi (Coleoptera: Dryopidae, Elmintidae). Guide per il riconoscimento delle specie animali delle acque interne italiane. C.N.R. AQ/1/6, 2, pp. 1–79.

Perco, F., P. Merluzzi & K. Kravos (2006): La Foce dell'Isonzo e l'Isola della Cona. Laguna, Mariano del Friuli, pp. 1–144.

Pirisinu, Q. (1981): Palpicorni (Coleoptera: Hydraenidae, Helophoridae, Spercheidae, Hydrochidae, Hydrophilidae, Sphaeridiidae). Guide per il riconoscimento delle specie animali delle acque interne italiane. C.N.R. AQ/1/128, 13, pp. 1–97.

Rossaro, B. (1982): Chironomidi, 2 (Diptera Chironomidae: Orthocladiinae). Guide per il riconoscimento delle specie animali delle acque interne italiane. C.N.R. AQ/1/171, 16, pp. 1–80.

Stoch, F. (1995): Indigine ecologico-faunistica sui popolamenti a entomostraci di alcuni stagni d'acqua salmastra dell'Isola della Cona (foce del Fiume Isonzo, Italia nordorientale). Gortania – Atti Mus. Friul. St. Nat., 16, 151–173.

Stoch, F. (1999a): I macroinvertebrati delle acque interne del Friuli-Venezia Giulia (Italia nordorientale): anfipodi (Crustacea, Amphipoda). Gortania – Atti Mus. Friul. St. Nat., 21, 133–160.

Stoch, F. (1999b): I macroinvertebrati delle acque interne del Friuli Venezia Giulia (Italia nordorientale): isopodi (Crustacea, Isopoda). Gortania – Atti Mus. Friul. St. Nat., 21, 161–176.

Stoch, F. (2000): How many endemic species? Species richness assessment and conservation priorities in Italy. Belg. J. Entomol., 2(1), 125–133.

Street, M. (1982): The use of waste straw to promote the production of invertebrate foods for waterfowl in manaide wetlands. Managing Wetlands and Their Birds. International Waterfowl Research Bureau, pp. 98–103.

Tamanini, L. (1979): Eterotteri acquatici (Heteroptera: Gerromorpha, Nepomorpha). Guide per il riconoscimento delle specie animali delle acque interne italiane. C.N.R. AQ/1/45, 6, pp. 1–106.

Valk van der, A. G. (1990): Response of Wetland Vegetation in Water level. Wetland Management and Restoration. Swedish environmental protection agency, pp. 7–16.

Allegato 1: Taxa rinvenuti nell'area M nel luglio 2001.
Priloga 1: Taksoni, odkriti v območju M julija 2001.

Stazione		**M1**	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**	**M11**	**M12**	**M13**	**M14**	**M15**	**M16**	**M17**	**M18**
Gastropoda	Viviparidae *Viviparus contectus*																		1
	Physidae *Physa acuta*	3	5	3		2		6		12	1		6	12	3				1
Annelida	Polychaeta				31														
	Oligochaeta Tubificidae	147	245				1			8									56
	Oligochaeta Enchytraeidae			134															
Crustacea	Malacostraca Amphipoda				10														
Odonata	Zigoptera Coenagrionidae *Ischnura*				1			4						8					
	Anisoptera Aeshnidae *Hemianax*													1					
	Anisoptera Libellulidae *Orthetrum*					2		4					2	5	1				
	Anisoptera Libellulidae *Crocothemis*													1					
	Anisoptera Libellulidae *Tarnetrum*												6	3					
Hemiptera	Heteroptera Corixidae *Sigara*							2							1				
	Heteroptera Pleidae *Plea*			1						1			1	3					
Coleoptera	Haliplidae									2									
	Larve Haliplidae									1			1						
	Larve Hygrobiidae													1					
	Dytiscidae			1						2				4					
	Hydrophilidae	2	5	1		2		5			1							1	
	Larve Hydrophilidae	3	7	6		4		6			4			1	6	2		1	
	Sphaeridiidae		6																
	Larve Dryopidae									2									
	Larve indet.									2								4	2
Diptera	Limoniidae cfr		1															1	
	Pupa Limoniidae cfr							2		5									1
	Ceratopogonidae Dasyheleinae	1																	
	Chirnomidae Tanypodinae	1					1	4			1				1				
	Chironomidae Chironominae Chironomini	2	3	3	26	19	7	121			14		1	6	37	31	2	10	2
	Chironomidae Chironominae Tanytarsini														1				
	Chironomidae Orthocladiinae														1				
	Tabanidae	1																	
	Ephydridae																3		
	Pupa Muscidae cfr														1				
	N° esemplari	**160**	**272**	**149**	**68**	**29**	**9**	**154**	**0**	**35**	**21**	**0**	**17**	**45**	**52**	**33**	**5**	**17**	**63**
	N° esemplari/m^2	**727**	**1236**	**677**	**309**	**132**	**41**	**700**	**0**	**159**	**95**	**0**	**77**	**205**	**236**	**150**	**23**	**77**	**286**

Allegato 2: Taxa rinvenuti nell'area M nel marzo 2002.
Priloga 2: Taksoni, odkriti v območju M marca 2002.

Stazione		M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18
Gastropoda	Physidae *Physa acuta*								1				1					3	
Annelida	Polychaeta				4														
	Oligochaeta Tubificidae	93	39	10				1	17	81			1					5	32
Crustacea	Branchiopoda Cladocera													1					
	Ostracoda	1								1				1	1				
	Malacostraca Isopoda				1							1							
Odonata	Anisoptera Libellulidae *Orthetrum*									1									
Hemiptera	Heteroptera Corixidae *Sigara*	2							3	2			1	2				4	
Coleoptera	Larve Haliplidae								1										
	Dytiscidae										1								
	Hydrophilidae	1	1							1									
	Larve Hydrophilidae	2	2			2		3	8	6	1	3	5		10		1	16	
Diptera	Limoniidae cfr		3		1						1							3	
	Pupa Limoniidae cfr									2	1								
	Ceratopogonidae Dasyheleinae	29	3	4	1				1	10							1		
	Chirnomidae Tanypodinae	9	4	2				2		2			2	3	2			1	
	Chironomidae Orthocladiinae	1						1										3	
	Chironomidae Chironominae Chironomini	14	31	23	19	21		55	9	7		78	84	43	85	1	15	32	12
	Chironomidae Chironominae Tanytarsini	1	1										4	9	7			1	
	N° esemplari	**153**	**84**	**39**	**26**	**23**	**0**	**62**	**40**	**113**	**4**	**82**	**98**	**59**	**105**	**1**	**17**	**68**	**44**
	N° esemplari/m^2	**695**	**382**	**177**	**118**	**105**	**0**	**282**	**182**	**514**	**18**	**373**	**445**	**268**	**477**	**5**	**77**	**309**	**200**

Allegato 3: Taxa rinvenuti nell'area M nel luglio 2002.
Priloga 3: Taksoni, najdeni v območju M julija 2002.

Stazione		M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18
Gastropoda	Physidae *Physa acuta*	73	9	13			14	4	35	17	29	3	30	28	27	1	4	15	8
	Lymnaeidae *Limnaea peregra*								2				1	1				4	
	Acroloxidae *Acroloxus lacustris*	1																	
Annelida	Polychaeta				1														
	Oligochaeta Tubificidae	18	231	17			2	12	91	27			6		70				
Crustacea	Ostracoda								1					1				1	4
	Malacostraca Isopoda									1			1						
	Malacostraca Amphipoda				1														
Odonata	Zigoptera Coenagrionidae *Ischnura*		2						1	2					1			1	
	Zigoptera Coenagrionidae *Enallagma*	2																	
	Zigoptera indet.													2					
	Anisoptera Cordulidae												1						
	Anisoptera Libellulidae *Orthetrum*							1			3	2	2	1	1				
	Anisoptera Libellulidae *Crocothemis*								1						1				
	Anisoptera Libellulidae *Tarnetrum*											1							
	Anisoptera indet.								2										

Stazione		**M1**	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**	**M11**	**M12**	**M13**	**M14**	**M15**	**M16**	**M17**	**M18**
Hemiptera	Heteroptera Corixidae *Sigara*	3		1							10		3		2		21	2	10
	Heteroptera indet.										5		2						
Coleoptera	Larve Haliplidae								1										
	Dytiscidae										3								
	Larve Dytiscidae						1												
	Hydrophilidae			1			1				1		1	1					
	Larve Hydrophilidae	14	44	25		3	7	8	25	2	11	9	9	24	20	3	9	6	38
Diptera	Limoniidae cfr	3	1						16		1	1			2				
	Pupa Limoniidae cfr						1		3										
	Ceratopogonidae Dasyheleinae	1	2						2	1				1					
	Chirnomidae Tanypodinae	5	11	5		1	1		7	4	9	4	9	8	7	1		2	
	Chironomidae Chironominae Chironomini	11	11	14	1	2	23	1		11	250	45	97	75	31	1	269	12	98
	Chironomidae Chironominae Tanytarsini										3		3	1					
	N° esemplari	**131**	**311**	**76**	**3**	**6**	**50**	**26**	**187**	**65**	**325**	**65**	**165**	**143**	**162**	**6**	**303**	**43**	**158**
	N° esemplari/m^2	**595**	**1414**	**345**	**14**	**27**	**227**	**118**	**850**	**295**	**1477**	**295**	**750**	**650**	**736**	**27**	**1377**	**195**	**718**

Allegato 4: Taxa rinvenuti nell'area V nel luglio 2001.
Priloga 4: Taksoni, najdeni v območju V julija 2001.

Stazione		**V1**	**V2**	**V3**	**V4**	**V5**	**V6**	**V7**
Annelida	Polychaeta	20	3		6	2	1	
Crustacea	Malacostraca Decapoda	1						
Hemiptera	Heteroptera Corixidae *Sigara*				2	3	1	
Coleoptera	Hydrophilidae	1						
	Chrysomelidae				1			
	Larve indet.						1	1
Diptera	Limoniidae cfr							1
	Pupa Limoniidae cfr				1			
	Tipulidae							1
	Chironomidae Chironominae Chironomini						1	
	N° esemplari	**22**	**3**	**0**	**10**	**5**	**4**	**3**
	N° esemplari/m^2	**100**	**14**	**0**	**45**	**23**	**18**	**14**

Allegato 5: Taxa rinvenuti nell'area V nel marzo 2002.
Priloga 5: Taksoni, najdeni v območju V marca 2002.

Stazione		**V1**	**V2**	**V3**	**V4**	**V5**	**V6**	**V7**
Gastropoda	Acroloxidae *Acroloxus lacustris*	3						
Annelida	Oligochaeta Tubificidae	7						
Crustacea	Ostracoda					2		
	Malacostraca Isopoda	1	1					
Hemiptera	Heteroptera Corixidae *Sigara*	1			1	1		
Coleoptera	Hydrophilidae					1		
	L. Hydrophilidae				4			
Diptera	Chirnomidae Tanypodinae				2			1
	Chironomidae Chironominae Chironomini	92	19	5	6	16	2	20
	Chironomidae Chironominae Tanytarsini							2
	Chironomidae Orthocladiinae							1
	Stratiomydae	1						
	N° esemplari	**105**	**20**	**5**	**13**	**20**	**2**	**24**
	N° esemplari/m^2	**477**	**91**	**23**	**59**	**91**	**9**	**109**

Allegato 6: Taxa rinvenuti nell'area V nel luglio 2002.
Priloga 6: Taksoni, najdeni v območju V julija 2002.

Stazione		**V1**	**V2**	**V3**	**V4**	**V5**	**V6**	**V7**
Gastropoda	Physidae *Physa acuta*					3	1	12
Annelida	Polychaeta		1					
	Oligochaeta Tubificidae	1						
Crustacea	Malacostraca Amphipoda		1					
	Malacostraca Decapoda				1			
Odonata	Zigoptera Coenagrionidae *Ischnura*	4						6
	Anisoptera indet.	1					1	1
Hemiptera	Heteroptera Corixidae *Sigara*	2	10	3	2	15	1	3
	Heteroptera indet.						1	
Coleoptera	Hydrophilidae							1
	L. Hydrophilidae	4	5	2		7	7	9
	L. Haliplidae		1					
Diptera	Limoniidae cfr	9					2	6
	Ceratopogonidae Dasyheleinae	1						
	Chirnomidae Tanypodinae	9	2		1		9	2
	Chironomidae Chironominae Chironomini	24	14	8	50	129	13	6
	Chironomidae Chironominae Tanytarsini	21	2			2	7	3
	Chironomidae Orthocladiinae							1
	N° esemplari	**76**	**36**	**13**	**54**	**156**	**42**	**50**
	N° esemplari/m^2	**345**	**164**	**59**	**245**	**709**	**191**	**227**

Original scientific article
Received: 2008-03-25

UDC 595.754(497.4)

HETEROPTERA OF SLOVENIA, V: PENTATOMOMORPHA II AND ADDITIONS TO THE PREVIOUS PARTS

Andrej GOGALA
Slovenian Museum of Natural History, SI-1001 Ljubljana, Prešernova 20, P. O. Box 290, Slovenia
E-mail: agogala@pms-lj.si

ABSTRACT

Species of the superfamilies Coreoidea and Pentatomoidea occurring in Slovenia are listed and data on the examined specimens presented. Seven species are reported for Slovenia for the first time: Coriomeris affinis *(Herrich-Schaeffer, 1839),* Geotomus elongatus *(Herrich-Schaeffer, 1840),* Psacasta exanthematica *(Scopoli, 1763),* Neottiglossa bifida *(A. Costa, 1847),* Neottiglossa lineolata *(Mulsant & Rey, 1852),* Acrosternum heegeri *Fieber, 1861 and* Sciocoris sulcatus *Fieber, 1851.* Ventocoris rusticus *(Fabricius, 1781) has been found only in 2007. Some additional species of the families treated in previous contributions are also reported for Slovenia:* Saldula arenicola *(Scholtz, 1847),* Dictyla nassata *(Puton, 1874),* Loricula pselaphiformis *Curtis, 1833,* Nabis ericetorum *Scholtz, 1847,* Coranus subapterus *(De Geer, 1773),* Chlamydatus pullus *(Reuter, 1870) and* Psallus albicinctus *(Kirschbaum, 1856).*

Key words: Heteroptera, Pentatomomorpha, Coreoidea, Pentatomoidea, fauna, Slovenia

HETEROPTERA IN SLOVENIA, V: PENTATOMOMORPHA II E AGGIUNTE ALLE PARTI PRECEDENTI

SINTESI

L'artico presenta la lista di specie delle superfamiglie Coreoidea e Pentatomoidea presenti in Slovenia e dati riguardanti alcuni degli esemplari esaminati. Sette specie vengono segnalate per la prima volta in Slovenia: Coriomeris affinis *(Herrich-Schaeffer, 1839),* Geotomus elongatus *(Herrich-Schaeffer, 1840),* Psacasta exanthematica *(Scopoli, 1763),* Neottiglossa bifida *(A. Costa, 1847),* Neottiglossa lineolata *(Mulsant & Rey, 1852),* Acrosternum heegeri *Fieber, 1861* e Sciocoris sulcatus *Fieber, 1851.* Ventocoris rusticus *(Fabricius, 1781) è stata trovata solo nel 2007. Vengono inoltre aggiunte alcune specie di famiglie riportate nei contributi precedenti, segnalate per la Slovenia:* Saldula arenicola *(Scholtz, 1847),* Dictyla nassata *(Puton, 1874),* Loricula pselaphiformis *Curtis, 1833,* Nabis ericetorum *Scholtz, 1847,* Coranus subapterus *(De Geer, 1773),* Chlamydatus pullus *(Reuter, 1870)* e Psallus albicinctus *(Kirschbaum, 1856).*

Parole chiave: Heteroptera, Pentatomomorpha, Coreoidea, Pentatomoidea, fauna, Slovenia

INTRODUCTION

Species of the superfamilies Coreoidea and Pentatomoidea are best known members of the subordo Heteroptera to the general public. They are large enough, of noticeable shapes and colours, and known for their distinctive smell, result of the defensive role of the thoracic glands secretions. Most species are phytophaguous, but members of the subfamily Asopinae within the Pentatomidae are important predators in forests. Parental care is known in many members of the Pentatomoidea. It is important not only for the protection of the young but also to ensure the transfer of intestinal symbionts from the mother to offspring (Gogala *et al.*, 1998). Vibrational communication, which is important in courtship, is achieved by low frequency body vibration, tymbalisation, and/or stridulation (M. Gogala, 2006).

Scopoli (1763) listed 11 species of Pentatomoidea and 4 of Coreoidea in his *Entomologia carniolica*. He was the first to describe 7 species, but only two of them with type locality in Slovenia mentioned: *Megalotomus junceus* from Ljubljana and *Eysarcoris aeneus* from Idrija. The type specimens of *Eurydema dominulus* were most probably from Slovenian territory as well, while those of *Dicranocephalus agilis* could be from Italy or Slovenia, as the Austrian coastal region is mentioned. *Coriomeris denticulatus, Canthophorus dubius* and *Psacasta exanthematica* were collected by him in Trieste, which is now in Italy. *Psacasta exanthematica* was found across the border in Slovenia no earlier than in 2005 (Fig. 1).

Gogala & Moder (1960) listed 28 species of the Coreoidea and 63 species of the Pentatomoidea for the territory of Slovenia. A. & M. Gogala (1989) raised these numbers to 35 species of the Coreoidea and 74 species of the Pentatomoidea. For the present contribution, all the material kept in the Slovenian Museum of Natural History was checked and identifications proved or corrected. The exact localities of examined specimens are published here mostly for the first time.

Some species of the families treated in previous contributions were discovered in Slovenia after these contributions were published or the records were communicated by other heteropterists. These species are listed at the end of this work. Additional photographs and maps of distribution of the Slovenian Heteroptera are available online at the web address: http://www2.pms-lj.si/heteroptera/.

Fig. 1: *Psacasta exanthematica* ***(Scopoli) on*** *Onosma javorkae* ***at Sela in the Slovenian Karst.***
Sl. 1: *Psacasta exanthematica* ***(Scopoli) na javorkinem rdečem korenu v Selah na Krasu.***

LIST OF SPECIES

STENOCEPHALIDAE

Dicranocephalus agilis (Scopoli, 1763)
Scopoli, 1763: "In Austriaco litorali" – coastal region (Italy or Slovenia); Gogala & Moder, 1960: Ljubljana, Šmarnogorska Grmada, Šmartno ob Savi, Črnomelj, Pokojišče, Hotedršica; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Bela krajina: Črnomelj, WL14, 7. 5. 1933, Staudacher leg.
Ljubljana: Ježica, VM60, 8. 6. 1930, Staudacher leg.
Šmarna gora: Grmada, južno pobočje, VM50, 13. 2. 1955, M. Gogala leg.
Logatec, Hotedršica, VL38, 24. 9. 1949, S. Brelih leg.
Ilirska Bistrica, Jelšane, VL43, 21. 6. 1983, M. Gogala leg.
Matarsko podolje: Podgrad, VL34, 5. 5. 1984, A. & M. Gogala leg.
Slavnik, VL14, 2. 6. 1984, A. & M. Gogala leg.
Istra: Portorož, UL94, 15. 10. 1986, A. & M. Gogala leg.
Ljubljansko barje: Notranje Gorice, VL59, 31. 5. 1987, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 16. 7. 1989, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 18. 5. 1990, A. & M. Gogala leg.
Gorjansko, UL97, 27. 4. 1992, A. & M. Gogala leg.
Ljubljana: Žale, VM60, 17. 4. 2000, A. & M. Gogala leg.
Log, Lukovica, VL59, 10. 7. 2006, M. Gogala leg.
Obrov, Golac, VL24, 8. 6. 2000, S. Brelih leg.

Obrov, Zagrad, Goli vrh, VL23, 27. 5. 1999, S. Gomboc & D. Kofol leg.
Divača, VL26, 19. 5. 1979, V. Furlan leg.
Brezje pri Dobrovi, VL49, 5. 5. 1983, M. Zdešar leg.
Loški potok, VL66, 8. 6. 1997, V. Furlan leg.
Orešje na Bizeljskem, WM50, 25. 5. 1993, V. Furlan leg.
Bela krajina: Žuniči, WL23, 27. 4. 1983, V. Furlan leg.
Ljubljana: Golovec, VL69, 15. 5. 1990, V. Furlan leg.

Dicranocephalus albipes (Fabricius, 1781)
Stenocephalus neglectus (Herrich-Schaeffer, 1835)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Črni Kal; A. & M. Gogala, 1989, 1994
Specimens examined:
Podgorski kras: Petrinje, VL14, 11. 7. 1986, A. & M. Gogala leg.
Istra: Koštabona, VL03, 7. 8. 1986, 7. 6. 1987, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 5. 5. 1989, A. & M. Gogala leg.
Črnotiče, VL14, 8. 7. 1990, A. & M. Gogala leg., 12. 7. 1990, V. Furlan leg.
Sočerga, Veli Badin, VL13, 14. 6. 1991, A. & M. Gogala leg., 16. 5. 1990, V. Furlan leg.
Hrpelje, Prešnica, VL14, 6. 7. 1998, S. Brelih leg., 22. 6. 1991, V. Furlan leg.

Dicranocephalus marginicollis (Puton, 1881)
Stenocephalus pruinosus Horváth, 1887
Horváth, 1887b: Prewald (= Razdrto) – lectotype of *S. pruinosus*

Dicranocephalus medius Mulsant & Rey, 1870)
Gogala & Moder, 1960: Šmartno ob Savi, Podzemelj, Adlešiči; A. & M. Gogala, 1986, 1989; Protić, 1987: Podčetrtek
Specimens examined:
Prekmurje: Petišovci, XM15, 30. 4. 1983, A. & M. Gogala leg.
Ljubljansko barje: Log, Lukovica, VL59, 3. 5. 1984, A. & M. Gogala leg.
Savinjske Alpe: Luče, Veža, Planica, VM73, 7. 1983, B. Drovenik leg.

RHOPALIDAE

Brachycarenus tigrinus (Schilling, 1829)
Gogala & Moder, 1960: Koper; A. & M. Gogala, 1989, 1994
Specimens examined:
Kraški rob: Črni Kal, VL14, 17. 2. 1988, A. & M. Gogala leg.
Sp. Branica, Čipnje, VL07, 18. 7. 1991, A. & M. Gogala leg.

Corizus hyoscyami (Linnaeus, 1758)
Montandon, 1886: Gorica; Gogala & Moder, 1960; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Wochein (= Bohinj), VM12, 29. 6. 1930, Staudacher leg.
Veldes (= Bled), VM33, 19. 7. 1931, Staudacher leg.
Šklendrovec, WM00, 28. 4. 1934, Staudacher leg.
Radovljica, Lancovo, VM33, 4. 8. 1929, Staudacher leg.
Ljubljana, Črnuče, VM60, 25. 6. 1933, Staudacher leg.
Neumarktl (= Tržič), VM43, 22. 9. 1935, Staudacher leg.
Bohinj: Ukanc, VM02, 3. 7. 1978, A. & M. Gogala leg.
Ljubljana, Mestni log, VL59, 14. 5. 1983, A. & M. Gogala leg.
Jezersko, VM64, 14. 8. 1983, A. & M. Gogala leg.
Slavnik, VL14, 2. 6. 1984, A. & M. Gogala leg.
Brkini: Barka, VL25, 28. 7. 1984, A. & M. Gogala leg.
Polhograjsko hrib.: Črni Vrh, Pasja ravan, VM40, 15. 8. 1984, A. & M. Gogala leg.
Čatež ob Savi, WL48, 6. 5. 1986, A. & M. Gogala leg.
Šmarje pri Jelšah, WM42, 17. 8. 1988, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 2. 7. 1989, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 18. 5. 1990, A. & M. Gogala leg.
Trstelj, UL98, 19. 8. 1990, A. & M. Gogala leg.
Hrastnik, Krnice, WM00, 26. 5. 1997, M. Gogala leg.
Koper, Bertoki, Škocjanski zatok, VL04, 22. 7. 2000, A. Gogala leg.
Ig, Kremenica, VL68, 23. 5. 1998, S. Brelih leg.
Hrpelje, Prešnica, VL14, 23. 5. 1999, 7. 6. 1999, S. Brelih leg.
Podsreda, Trebča Gorca, WM40, 18. 5. 2000, S. Brelih leg.
Gorjanci: Jugorje, WL16, 27. 4. 1983, V. Furlan leg.
Bela krajina: Podzemelj, WL25, 28. 4. 1983, V. Furlan leg.
Vinica, WL13, 29. 4. 1983, V. Furlan leg.
Novo mesto, Trška gora, WL17, 21. – 22. 5. 1983, V. Furlan leg.
Luče, Igla, VM73, 30. 5. 1983, B. Drovenik leg.
Kamniška Bistrica, Konec, 1100 m, VM63, 18. 8. 1984, V. Furlan leg.
Zasavje: Podkum, WM00, 24. 5. 1989, V. Furlan leg.
Lipica, VL15, 25. 5. 1985, V. Furlan leg.
Črni Kal, Črnotiče, VL14, 29. 4. 1990, V. Furlan leg.
Gornji Ig, VL68, 23. 5. 1987, V. Furlan leg.
Senožeče, Gabrče, VL26, 26. 5. 1987, V. Furlan leg.
Ljubljana, Golovec: Orle, VL69, 21. 4. 1985, V. Furlan leg.
Mrzlica, 1100 m, WM01, 13. 6. 1991, V. Furlan leg.
Kozjansko: Šentvid pri Planini, WM30, 11. 5. 1993, V. Furlan leg.
Zaplana, Cesarski vrh, VL49, 27. 5. 1991, V. Furlan leg.

Liorhyssus hyalinus (Fabricius, 1794)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Slavnik; A. & M. Gogala, 1986
Specimens examined:
Prekmurje: Lendava, XM15, 6. 7. 1980, A. & M. Gogala leg.
Ljubljansko barje: Log, Dragomer, VL59, 25. 7. 1980, A. Gogala leg.
Sp. Branica, Čipnje, VL07, 18. 7. 1991, A. & M. Gogala leg.
Istra: Strunjan, UL94, 12. 5. 1998, A. Gogala leg.
Kras: Brje pri Komnu, VL07, 14. 5. 2000, A. & M. Gogala leg.
Ljubljana, Golovec: Orle, VL69, 4. 5. 1985, V. Furlan leg.

Maccevethus errans caucasicus (Kolenati, 1845)
? *Maccevethus lineola* (Fabricius, 1787)
A. & M. Gogala, 1989 (as *M. lineola),* 1994 (as *M. corsicus);* Gogala, 1991 (as *M. corsicus),* 1996
Specimens examined:
Istra: Boršt, VL03, 3. 5. 1986, A. & M. Gogala leg.
Padna, UL93, 13. 7. 1995, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 9. 6. 1990, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 10. 9. 1995, A. & M. Gogala leg.
Rakitovec, Kavčič, VL13, 26. 5. 2000, A. Gogala leg.
Trstelj, UL98, 25. 6. 2000, A. & M. Gogala leg.

Rhopalus maculatus (Fieber, 1837)
Gogala & Moder, 1960: Ljubljana – Rakovnik; A. & M. Gogala, 1986, 1989
Specimens examined:
Ljubljana: Rakovnik, VL69, 24. 6. 1954, M. Gogala leg.
Turjak, VL78, 25. 5. 1980, A. & M. Gogala leg.
Ljubljansko barje: Vnanje gorice, VL59, 27. 8. 1980, A. & M. Gogala leg.
Dobrova, VM50, 26. 9. 1981, A. & M. Gogala leg.
Ljubljana, Mestni log, VL59, 14. 5. 1983, A. & M. Gogala leg.
Log, Lukovica, VL59, 27. 4. 1983, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 7. 8. 1983, 11. 7. 1987, 10. 9. 1988, A. & M. Gogala leg.
Postojna, Landol, VL37, 21. 9. 1983, A. & M. Gogala leg.
Rakitna, VL58, 31. 7. 1984, A. & M. Gogala leg.
Osilnica, Plešce, slov. stran reke, VL74, 27. 7. 1985, A. & M. Gogala leg.
Šmarje pri Jelšah, WM42, 17. 8. 1988, A. & M. Gogala leg.
Sp. Brnik, VM61, 7. 9. 1988, A. & M. Gogala leg.
Gradišče pri Lukovici, VM71, 11. 7. 1996, A. Gogala leg.
Rakov Škocjan, VL47, 20. 7. 2002, A. Gogala leg.
Cerkniško jezero: Gorenje Jezero, VL56, 23. 8. 2002, A. Gogala leg.
Prekmurje: Muriša, XM24, 19. 6. 1996, S. Gomboc leg.
Goričko: Mačkovci, WM88, 10. 4. 1997, S. Gomboc leg.
Ljubljana: Dobrunje – Sv. Urh, VL69, 25. 6. 1997, V. Furlan leg.
Bela krajina: Gradac, WL15, 28. 4. 1983, V. Furlan leg.
Vinica, WL13, 29. 4. 1983, V. Furlan leg.
Podkum, Sopota, WM00, 14. 6. 1990, V. Furlan leg.

Rhopalus conspersus (Fieber, 1837)
Gräffe, 1911: Logatec; Gogala & Moder, 1960; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Ilirska Bistrica, VL44, 31. 7. 1962, E. Pretner leg.
Kamnik pod Krimom, Žalostna gora, VL59, 26. 5. 1979, A. & M. Gogala leg.
Istra: Gračišče, VL14, 1. 5. 1981, A. & M. Gogala leg.
Bohinj: Ukanc, VM02, 16. 8. 1981, A. & M. Gogala leg.
Vrhnika, VL49, 11. 7. 1982, A. & M. Gogala leg.
Sorica, Soriška planina, VM22, 23. 6. 1984, A. & M. Gogala leg.
Brkini: Slivje, VL24, 28. 7. 1984, A. & M. Gogala leg.
Črni Vrh, Pasja ravan, VM40, 4. 6. 1985, A. & M. Gogala leg.
Koštabona, VL03, 7. 6. 1987, A. & M. Gogala leg.
Ljubljana: Savlje, VM60, 11. 4. 1988, A. & M. Gogala leg.
Čaven, VL08, 11. 6. 1988, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 10. 9. 1988, A. & M. Gogala leg.
Brje pri Komnu, VL07, 12. 6. 1989, A. & M. Gogala leg.
Julijske Alpe: Mangart, sedlo, UM94, 2. 7. 1993, A. & M. Gogala leg.
Kras: Trstelj, UL98, 25. 6. 2000, A. & M. Gogala leg.
Polhograjsko hrib.: Črni Vrh, VM40, 25. 8. 2005 on *Calluna vulgaris*, A. Gogala leg.
Bela krajina: Žuniči, WL23, 27. 4. 1983, V. Furlan leg.
Vinica, WL13, 29. 4. 1983, V. Furlan leg.
Semič, WL15, 30. 4. 1983, V. Furlan leg.
Krma, VM14, 14. 5. 1983, V. Furlan leg.
Lipica, VL15, 25. 5. 1985, V. Furlan leg.
Povir, VL16, 31. 7. 1984, V. Furlan leg.
Ig, Iška vas, VL68, 3. 5. 1987, V. Furlan leg.
Črni Kal, Socerb, VL14, 8. 5. 1990, V. Furlan leg.
Sočerga, Mlini, Veli Badin, VL13, 12. 7. 1990, V. Furlan leg.
Loški potok, VL66, 17. 5. 1997, V. Furlan leg.
Mrzlica, 1100 m, WM01, 13. 6. 1991, V. Furlan leg.
Vršič, Prisojnik, 1800 m, VM04, 30. 7. 1991, V. Furlan leg.
Zaplana, Cesarski vrh, VL49, 27. 5. 1991, V. Furlan leg.

Rhopalus lepidus Fieber, 1861
Gogala & Moder, 1960
Note: Gogala & Moder mentioned f. *lepida* of the species *R. parumpunctatus*. The record of the species is dubious.

Rhopalus parumpunctatus Schilling, 1829
Gogala & Moder, 1960; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Laibach (= Ljubljana), 21. 9. 1928, 30. 9. 1928, 22. 8. 1931, Staudacher leg.
Radovljica, Lancovo, VM33, 4. 8. 1929, Staudacher leg.
Črni Kal, VL14, 30. 6. 1979, 9. 7. 1980, A. & M. Gogala leg.
Ljubljana, Tacen, VM50, 2. 3. 1980, A. & M. Gogala leg.
Istra: Koštabona, VL03, 25. 6. 1981, M. Gogala leg.
Ljubljana: Šiška, VM50, 19. 8. 1981, A. Gogala leg.
Bela krajina: Vinica, Zilje, WL23, 13. 9. 1981, A. & M. Gogala leg.
Hrpelje, VL15, 2. 7. 1982, A. & M. Gogala leg.
Goričko: Gornji Petrovci, WM98, 1. 5. 1983, A. & M. Gogala leg.
Ljubljana: Mestni log, VL59, 14. 5. 1983, A. & M. Gogala leg.
Prekmurje: Dobrovnik, XM06, 23. 7. 1983, A. & M. Gogala leg.
Polhograjsko hrib.: Črni Vrh, VM40, 4. 8. 1983, A. & M. Gogala leg.
Brkini: Slivje, VL24, 28. 7. 1984, A. & M. Gogala leg.
Velike Bloke, 2 km E, VL67, 24. 8. 1985, A. & M. Gogala leg.
Zg. Radovna, VM14, 28. 8. 1988, A. & M. Gogala leg.
Sp. Brnik, VM61, 7. 9. 1988, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 21. 5. 1989, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 18. 5. 1990, A. & M. Gogala leg.
Dragonja, UL93, 7. 3. 1997, A. & M. Gogala leg.
Kranj, Brdo, VM52, 31. 8. 2006, A. Gogala leg.
Istra: Popetre, VL13, 9. 7. 1997, S. Brelih leg.
Podkum, WM00, 24. 5. 1989, V. Furlan leg.
Bela krajina: Podzemelj, WL25, 28. 4. 1983, V. Furlan leg.
Semič, Gornja Paka, WL15, 29. 4. 1983, V. Furlan leg.
Suha krajina: Žvirče, VL87, 7. 5. 1983, V. Furlan leg.
Muljava, VL88, 7. 5. 1983, V. Furlan leg.
Polhograjsko hrib.: Grmada, VM40, 13. 8. 1983, V. Furlan leg.
Senožeče, Gabrče, VL26, 26. 5. 1987, V. Furlan leg.

Rhopalus rufus Schilling, 1829
Gogala & Moder, 1960
Note: Gogala & Moder mentioned f. *rufa* of the species *R. parumpunctatus*. The record of the species is dubious.

Rhopalus subrufus (Gmelin, 1790)
Corizus capitatus (Fabricius, 1794)
Montandon, 1886: Gorica; Gogala & Moder, 1960; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Medvode, Utik, VM61, 20. 10. 1927, Staudacher leg.
Mežakla, VM24, 9. 5. 1920, Staudacher leg.
Otoče, VM42, 14. 5. 1933, Staudacher leg.
Bohinj: Ukanc, VM02, 26. 6. 1977, A. & M. Gogala leg.
Kamnik pod Krimom, Ponikve, VL58, 20. 6. 1982, A. & M. Gogala leg.
Slavnik, VL14, 2. 7. 1982, A. & M. Gogala leg.
Ljubljana: Savlje, VM60, 13, 3. 1983, A. & M. Gogala leg.
Ljubljansko barje: Log, Lukovica, VL59, 14. 5. 1983, A. & M. Gogala leg.
Brkini: Barka, VL25, 28. 7. 1984, A. & M. Gogala leg.
Istra: Labor, VL03, 9. 9. 1987, A. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 10. 9. 1988, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 9. 7. 1989, A. & M. Gogala leg.
Brestovica pri Komnu, UL97, 2. 5. 1990, A. & M. Gogala leg.
Istra: Sočerga, Veli Badin, VL13, 1. 8. 1990, A. & M. Gogala leg.
Koper, Bertoki, Škocjanski zatok, VL04, 6. 5. 2000, A. Gogala leg.
Ljubljana, VL69, 28. 9. 1996, V. Furlan leg.
Komen, Branik, VL07, 27. 5. 1998, S. Brelih leg.
Podsreda, Trebča Gorca, WM40, 9. 7. 1998, S. Brelih leg.
Hrpelje, VL15, 24. 6. 1999, S. Brelih leg.
Nanos: Šembijska bajta, 800 m, VL27, 14. 7. 1999, S. Brelih leg.
Nova Gorica, Panovec, UL98, 6. 7. 2000, S. Brelih leg.
Bela krajina: Podzemelj, WL25, 28. 4. 1983, V. Furlan leg.
Bela krajina: Semič, Stranska vas, WL15, 28. 4. 1983, V. Furlan leg.
Radovna, VM24, 14. 5. 1983, V. Furlan leg.
Lipica, VL15, 25. 5. 1985, V. Furlan leg.
Krim, 950 m, VL58, 23. 5. 1987, V. Furlan leg.
Ig, Iška vas, VL68, 3. 5. 1987, V. Furlan leg.
Črni Kal, Socerb, VL14, 8. 5. 1990, V. Furlan leg.
Topol, Sv. Katarina, VM50, 9. 6. 1991, V. Furlan leg.
Postojna, VL37, 10. 6. 1991, V. Furlan leg.
Kozjansko: Šentvid pri Planini, WM30, 11. 5. 1993, V. Furlan leg.
Novo mesto, Trška gora, WL17, 16. 6. 1991, V. Furlan leg.
Kozina, VL15, 22. 6. 1991, V. Furlan leg.
Loški potok, VL66, 17. 5. 1997, V. Furlan leg.
Unec, VL47, 10. 5. 1987, V. Furlan leg.
Zasavje: Kum, 1000 m, WM00, 30. 5. 1989, V. Furlan leg.

Stictopleurus abutilon (Rossi, 1790)
Gogala & Moder, 1960: Ljubljana, Slavnik; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Laibach (= Ljubljana), 21. 9. 1928, Staudacher leg.
Koper, Škocjanski zatok, VL04, 1. 7. 1979, 18. 5. 1980, A. & M. Gogala leg.
Kras: Štanjel, VL17, 22. 7. 1980, A. & M. Gogala leg.
Slavnik, VL14, 28. 6. 1982, A. & M. Gogala leg.
Prekmurje: Dobrovnik, Bukovniško jezero, XM07, 30. 4. 1983, A. & M. Gogala leg.
Korovci, WM77, 14. 6. 1987, A. & M. Gogala leg.
Istra: Dragonja, Stena, UL93, 1. 10. 1987, A. & M. Gogala leg.
Brje pri Komnu, VL07, 18. 6. 1989, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 18. 5. 1990, A. & M. Gogala leg.
Komen, Branik, VL07, 27. 5. 1998, S. Brelih leg.
Hrastovlje, Podpeč, VL14, 23. 4. 1998, S. Gomboc leg.
Nova Gorica, Panovec, UL98, 13. 9. 2000, S. Brelih leg.
Ljubljana, Golovec, VL69, 18. 6. 1982, V. Furlan leg.
Gorjanci: Jugorje, WL16, 27. 4. 1983, V. Furlan leg.
Novo mesto, Trška gora, WL17, 21. – 22. 5. 1983, V. Furlan leg.
Povir, VL16, 16. 5. 1984, V. Furlan leg.
Lipica, VL15, 25. 5. 1985, V. Furlan leg.
Bela krajina: Vinica, WL13, 29. 4. 1983, V. Furlan leg.

Stictopleurus crassicornis (Linnaeus, 1758)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Ljubljana, Brežice, Pokojišče, Šmartno ob Savi, Golica; A. & M. Gogala, 1986, 1989
Specimens examined:
Laibach (= Ljubljana), 14. 10. 1928, 27. 8. 1931, 2. 9. 1931, Staudacher leg.
Pokojišče, VL58, 27. 4. 1930, Staudacher leg.
Ljubljana, Črnuče, VM60, 3. 6. 1979, A. & M. Gogala leg.
Koper, Škocjanski zatok, VL04, 18. 5. 1980, A. & M. Gogala leg.
Postojna, Zagon, VL37, 21. 9. 1983, A. & M. Gogala leg.
Istra: Padna, UL93, 4. 11. 1983, A. & M. Gogala leg.
Brkini: Artviže, VL25, 28. 7. 1984, A. & M. Gogala leg.
Čaven, VL08, 11. 6. 1988, A. & M. Gogala leg.
Sp. Brnik, VM61, 7. 9. 1988, A. & M. Gogala leg.
Cerkniško jezero: Dolenje Jezero, VL56, 10. 9. 1988, A. & M. Gogala leg.
Zazid, Zalipnik, VL13, 26. 5. 2000, A. Gogala leg.
Kras: Brestovica pri Povirju, VL16, 10. 3. 2001, A. & M. Gogala leg.
Topol, Sv. Katarina, VM50, 9. 6. 1991, V. Furlan leg.
Muljava, Oslica, VL88, 1. 5. 1991, V. Furlan leg.
Maribor, Mariborski otok, WM45, 12. 5. 1992, V. Furlan leg.
Ljubljana, Golovec: Orle, VL69, 22. 3. 1989, V. Furlan leg.
Haloze: Cirkulane, Brezovec, WM73, 8. 8. 1998, S. Brelih leg.
Gorjanci: Jugorje, WL16, 27. 4. 1983, V. Furlan leg.
Gorjanci: Sv. Miklavž, WL26, 29. 8. 1990, V. Furlan leg.
Bela krajina: Črnomelj, Veliki Nerajec, WL14, 29. 4. 1983, V. Furlan leg.
Povir, VL16, 16. 5. 1984, V. Furlan leg.
Lipica, VL15, 25. 5. 1985, V. Furlan leg.

Stictopleurus pictus (Fieber, 1861)
Gogala, 1991
Specimens examined:
Strunjan, UL94, 22. 9. 1982, A. & M. Gogala leg.
Koštabona, Supotski slap, VL03, 12. 10. 1988, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 21. 7. 1990, 6. 8. 2006, A. & M. Gogala leg.
Koper, Bertoki, Škocjanski zatok, VL04, 22. 7. 2000, A. Gogala leg.
Istra: Padna, UL93, 28. 10. 2000, A. Gogala leg.

Stictopleurus punctatonervosus (Goeze, 1778)
Gogala & Moder, 1960: Ljubljana, Slavnik, Črni Kal, Piran; A. & M. Gogala, 1986, 1989, 1994; Protić, 1987: Podčetrtek
Specimens examined:
Ljubljana: Rožnik, VM50, 25. 9. 1954, M. Gogala leg.
Ljubljansko barje: Plešivica, VL59, 23. 4. 1978, A. & M. Gogala leg.
Črni Kal, VL14, 15. 4. 1979, A. & M. Gogala leg.
Koper, Bertoki, Škocjanski zatok, VL04, 18. 5. 1980, A. & M. Gogala leg., 23. 3. 2000, 22. 7. 2000, A. Gogala leg.
Ljubljana: Šiška, VM50, 19. 8. 1981, A. Gogala leg.
Ljubljana, Črnuče, VM60, 21. 6. 1982, A. & M. Gogala leg.
Kras: Štorje, VL16, 8. 6. 1983, A. & M. Gogala leg.
Portorož, Lucija, UL94, 2. 7. 1983, A. & M. Gogala leg.
Istra: Padna, UL93, 4. 11. 1983, A. & M. Gogala leg.
Strunjan, UL94, 16. 10. 1985, A. & M. Gogala leg.
Koštabona, VL03, 7. 6. 1987, A. & M. Gogala leg.
Koštabona, Supotski slap, VL03, 12. 10. 1988, A. & M. Gogala leg.
Prekmurje: Petišovci, XM15, 13. 6. 1987, A. & M. Gogala leg.
Šmarje pri Jelšah, WM42, 17. 8. 1988, A. & M. Gogala leg.
Brje pri Komnu, VL07, 5. 5. 1989, A. & M. Gogala leg., 19. 11. 2005, M. Gogala leg.
Izvir Rižane, VL14, 18. 2. 1990, A. & M. Gogala leg.
Osp, VL14, 18. 3. 1990, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 18. 5. 1990, A. & M. Gogala leg.
Kočevje, Dolga vas, VL95, 4. 7. 1997, S. Brelih leg.
Istra: Kozloviči, VL03, 9. 7. 1997, S. Brelih leg.
Novo mesto, Trška gora, WL17, 11. 6. 1992, V. Furlan leg.

Bistrica ob Sotli, Sedlarjevo, WM40, 23. 6. 1993, V. Furlan leg.
Muljava, Oslica, VL88, 1. 5. 1991, V. Furlan leg.
Kozina, VL15, 22. 6. 1991, V. Furlan leg.
Sp. Šklendrovec, WM00, 30. 5. 1991, V. Furlan leg.
Goričko: Sotina, WM78, 30. 7. 1998, S. Brelih leg.
Prekmurje: Murski Petrovci, WM86, 31. 7. 1998, S. Brelih leg.
Podsreda, Loke, WL49, 9. 7. 1998, S. Brelih leg.
Podsreda, Trebča Gorca, WM40, 9. 7. 1998, S. Brelih leg.
Hrpelje, VL15, 24. 6. 1999, S. Brelih leg.
Nova Gorica, Panovec, UL98, 15. 5. 2000, S. Brelih leg.
Lipica, VL15, 30. 5. 1982, V. Furlan leg.
Povir, VL16, 16. 5. 1984, V. Furlan leg.
Kresnice, Pogonik, VM80, 29. 7. 1989, V. Furlan leg.
Zasavje: Hrastnik, Podkraj, WM00, 14. 6. 1990, V. Furlan leg.
Bela krajina: Vinica, WL13, 29. 4. 1983, V. Furlan leg.

Myrmus miriformis (Fallén, 1807)
Gogala & Moder, 1960: Koper; A. & M. Gogala, 1986, 1989
Specimens examined:
Prekmurje: Filovci, XM06, 4. 7. 1980, A. & M. Gogala leg.
Poljčane, Makole, WM53, 15. 7. 1984, Mladinski raziskovalni tabor
Šmarje pri Jelšah, WM42, 17. 8. 1988, A. & M. Gogala leg.
Istra: Sečovlje, Fontanigge, UL93, 20. 9. 1980, 21. 9. 1982, 7. 8. 1986, 24. 8. 1991, A. & M. Gogala leg.
Ankaran, VL04, 28. 10. 2000, A. & M. Gogala leg.
Koper, Bertoki, Škocjanski zatok, VL04, 10. 6. 2000, A. Gogala leg.
Cerkniško jezero: Dolenje Jezero, VL56, 7. 8. 2001, A. Gogala leg.
Krško, Dolenja vas, WL48, 7. 8. 1977, V. Furlan leg.

ALYDIDAE

Micrelytra fossularum (Rossi, 1790)
Gogala & Moder, 1960: Piran; A. & M. Gogala, 1989; Gogala *et al.*, 1990
Specimens examined:
Istra: Portorož, UL94, 15. 10. 1986, A. & M. Gogala leg.
Strunjan, UL94, 17. 9. 1989, A. & M. Gogala leg.

Alydus calcaratus (Linnaeus, 1758)
Montandon, 1886: Gorica; Gogala & Moder, 1960; A. & M. Gogala, 1986, 1989; Protić, 1987: Podčetrtek
Specimens examined:
Stadtberg Rudolfswert (= Novo mesto), WL17, 2. 10. 1932, Staudacher leg.
Ljubljana: Grad, VM60, 18. 5. 1954, M. Gogala leg.
Ljubljana: Golovec, VL69, 17. 10. 1954, M. Gogala leg.
Ljubljana: Šiška, VM50, 3. 9. 1980, A. Gogala leg.
Prekmurje: Dobrovnik, XM06, 23. 7. 1983, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 7. 8. 1983, A. & M. Gogala leg.
Polhograjsko hrib.: Črni Vrh, VM40, 4. 8. 1983, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 9. 7. 1989, A. & M. Gogala leg.
Gornja Radgona, Apače, Segovci, WM77, 10. 8. 1998, S. Brelih leg.
Ljubljana: Bežigrad, VM60, 3. 9. 2005, D. Fekonja leg.

Camptopus lateralis (Germar, 1817)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Cerknica, Portorož, Piran, Koper; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Kras: Štanjel, VL17, 22. 7. 1980, A. & M. Gogala leg.
Istra: Padna, UL93, 16. 6. 1984, A. & M. Gogala leg.
Kubed, VL14, 24. 7. 1984, A. & M. Gogala leg.
Pomjan, VL03, 7. 9. 1985, A. & M. Gogala leg.
Koštabona, VL03, 7. 6. 1987, A. & M. Gogala leg.
Nova Gorica, Vogrsko, Kurnik, VL08, 17. 3. 1987, R. Jelinčič leg.
Brje pri Komnu, VL07, 28. 5. 1989, A. & M. Gogala leg.
Dragonja, Stena, UL93, 30. 8. 1989, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 1. 8. 1990, A. & M. Gogala leg., 12. 6. 1990, V. Furlan leg.
Sežana, VL16, 23. 3. 2001, A. & M. Gogala leg.
Komen, Branik, VL07, 27. 5. 1998, S. Brelih leg.
Hrpelje, Prešnica, VL14, 6. 7. 1998, S. Brelih leg.
Opatje selo, UL97, 27. 6. 1998, S. Gomboc leg.
Sočerga, Šeki, VL13, 14. 6. 1999, S. Brelih leg.

Megalotomus junceus (Scopoli, 1763)
Megalotomus limbatus (Herrich-Schaeffer, 1835)
Scopoli, 1763: Ljubljana – type locality; Montandon, 1886: Gorica; Gräffe, 1911: Logatec; Gogala & Moder, 1960: Ljubljana – Rožnik, Preserje, Šmartno ob Savi, Dobrova, Bohinj; A. & M. Gogala, 1986, 1989; Protić, 1987: Podčetrtek
Specimens examined:
Laibach (= Ljubljana), 15. 9. 1935, 8. 8. 1937, 11. 9. 1937, Staudacher leg.
Bovec, Čezsoča, UM83, 1. 8. 1953, S. Brelih leg.
Ljubljana, VM60, 16. 8. 1954 on *Rhamnus*, M. Gogala leg.
Ljubljana: Rožnik, VM50, 20. 8. 1954, M. Gogala leg.
Bela krajina: Vinica, Zilje, WL23, 13. 9. 1981, A. & M. Gogala leg.
Sp. Brnik, VM61, 2. 9. 1988 on *Rhamnus cathartica*, M. Gogala leg.
Trenta, VM03, 13. 7. 2001, A. & M. Gogala leg.
Lenart, Cerkvenjak, WM75, 31. 7. 2005, D. Fekonja leg.

COREIDAE

Bathysolen nubilus (Fallén, 1807)
Montandon, 1886: Gorica; A. & M. Gogala, 1986, 1989, 1994; Protić, 1987: Podčetrtek
Specimens examined:
Ljubljana: Savlje, VM60, 21. 4. 1984, 15. 4. 1987, 11. 4. 1988, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 9. 7. 1989, A. & M. Gogala leg.
Kraški rob: Socerb, VL14, 1. 8. 1990, A. & M. Gogala leg.

Bothrostethus annulipes (Herrich-Schaeffer, 1835)
A. & M. Gogala, 1986, 1994
Specimens examined:
Kubed, VL14, 24. 7. 1984, A. & M. Gogala leg.
Sočerga, VL13, 26. 7. 1984, A. & M. Gogala leg.
Istra: Izvir Rižane, VL14, 18. 2. 1990, A. & M. Gogala leg.
Kraški rob: Zazid, Lipnik, VL13, 5. 6. 2001, A. Gogala leg.
Istra: Sv. Peter, UL93, 27. 5. 1999, S. Gomboc & D. Kofol leg.

Ceraleptus gracilicornis (Herrich-Schaeffer, 1835)
Reuter, 1888: Gorica; A. & M. Gogala, 1986, 1989, 1994; Protić, 1987: Podčetrtek; Gogala *et al.*, 1990
Specimens examined:
Koper, Sermin, VL04, 16. 6. 1984, A. & M. Gogala leg.
Istra: Boršt, VL03, 3. 5. 1986, A. & M. Gogala leg.
Koštabona, VL03, 7. 6. 1987, A. & M. Gogala leg.
Brje pri Komnu, VL07, 5. 5. 1989, 10. 9. 1995, A. & M. Gogala leg.
Strunjan, UL94, 17. 9. 1989, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 18. 5. 1990, A. & M. Gogala leg.
Kras: Sveto, VL07, 29. 4. 2001, A. Gogala leg.
Goričko: Mačkovci, WM88, 10. 4. 1997, S. Gomboc leg.
Hrpelje, Prešnica, VL14, 23. 5. 1999, 7. 6. 1999, S. Brelih leg.
Koper, Škocjanski zatok, VL04, 23. 5. 2000, S. Brelih leg.
Dragonja, UL93, 4. 5. 2000, S. Brelih leg.
Lipica, VL15, 19. 5. 1979, V. Furlan leg.
Slavnik, VL14, 9. 6. 1979, V. Furlan leg.

Ceraleptus lividus Stein, 1858
Montandon, 1886: Gorica; A. & M. Gogala, 1986, 1994; Gogala *et al.*, 1990
Specimens examined:
Kras: Lipica, VL15, 30. 5. 1982, V. Furlan leg.
Brje pri Komnu, VL07, 21. 5. 1989, A. & M. Gogala leg.
Istra: Dragonja, Stena, UL93, 17. 9. 1989, A. & M. Gogala leg.
Brestovica pri Komnu, UL97, 2. 5. 1990, A. & M. Gogala leg.
Kras: Sveto, VL07, 28. 4. 2007, A. Gogala leg.
Hrpelje, Prešnica, VL14, 23. 5. 1999, S. Brelih leg.
Sočerga, Mlini, Veli Badin, VL13, 16. 5. 1990, V. Furlan leg.

Ceraleptus obtusus (Brullé, 1839)
Ceraleptus squalidus A. Costa, 1847
Montandon, 1886: Gorica; Gogala, 1991; A. & M. Gogala, 1994
Specimens examined:
Istra: Dragonja, Stena, UL93, 9. 6. 1990, A. & M. Gogala leg.
Sočerga, Mlini, Veli Badin, VL13, 16. 5. 1990, V. Furlan leg.

Coriomeris affinis (Herrich-Schaeffer, 1839)
Specimen examined:
Sela na Krasu, UL97, 29. 4. 2007 on *Onosma javorkae*, A. Gogala leg.
Additional record:
Sečovlje, Fontanigge, UL93, 6. 6. 2003, C. Rieger leg.

Coriomeris denticulatus (Scopoli, 1763)
Reuter, 1888: Gorica; Gogala & Moder, 1960: Ljubljana, Zagorje, Šklendrovec, Mavrlen, Slavnik, Črni Kal, Strunjan; A. & M. Gogala, 1986, 1989, 1994; Protić, 1987: Podčetrtek
Specimens examined:
Kamnik, Vodice, VM61, 13. 5. 1934, Staudacher leg.
Šklendrovec, WM00, 12. 6. 1932, Staudacher leg.
Medvode, Utik, VM61, 8. 6. 1931, Staudacher leg.
Zagorje ob Savi, WM01, 12. 6. 1932, Staudacher leg.
Laibach (= Ljubljana), 15. 10. 1936, Staudacher leg.
Ljubljana: Rožnik, VM50, 4. 6. 1954, M. Gogala leg.
Bohinj: Ukanc, VM02, 19. 6. 1977, A. & M. Gogala leg.
Črni Kal, VL14, 15. 4. 1979, A. & M. Gogala leg.
Slavnik, VL14, 31. 5. 1981, 23. 6. 1991, A. & M. Gogala leg.
Koštabona, VL03, 25. 6. 1981, M. Gogala leg.
Log, Lukovica, VL59, 14. 5. 1983, A. & M. Gogala leg.
Koper, Sermin, VL04, 16. 6. 1984, A. & M. Gogala leg.
Ljubljana: Savlje, VM60, 13. 3. 1983, A. & M. Gogala leg.
Boršt, VL03, 3. 5. 1986, A. & M. Gogala leg.
Goričko: Trdkova, WM89, 14. 6. 1987, A. & M. Gogala leg.
Brje pri Komnu, VL07, 5. 5. 1989, A. & M. Gogala leg.
Brestovica pri Komnu, UL97, 2. 5. 1990, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 18. 5. 1990, A. & M. Gogala leg.
Vinje pri Moravčah, VM71, 23. 5. 1997, A. Gogala leg.
Koper, Bertoki, Škocjanski zatok, VL04, 14. 5. 2000, A. Gogala leg.

Kodreti, Dolanci, VL17, 2. 5. 2000, A. Gogala leg.
Grčarevec, Planinsko polje, VL48, 20. 5. 2004, A. Gogala leg.
Sela na Krasu, UL97, 22. 5. 2005 on *Onosma*, A. Gogala leg.
Istra: Trebeše, VL13, 14. 4. 2007, A. & M. Gogala leg.
Hrpelje, Prešnica, VL14, 6. 7. 1998, 10. 5. 1999, S. Brelih leg.
Ig, Kremenica, VL68, 6. 1994, S. Brelih leg.
Novo mesto, Trška gora, WL17, 21. – 22. 5. 1983, 6. 6. 1987, V. Furlan leg.
Kras: Lipica, VL15, 25. 5. 1985, V. Furlan leg.
Divača, VL26, 25. 5. 1985, V. Furlan leg.
Senožeče, Gabrče, VL26, 26. 5. 1987, V. Furlan leg.
Ratitovec, Prtovč, VM32, 10. 6. 1984, V. Furlan leg.
Topol, Osredek, VM50, 5. 5. 1990, V. Furlan leg.
Borovak pri Podkumu, WM00, 9. 5. 1990, V. Furlan leg.
Kozjansko: Sedlarjevo, WM40, 23. 6. 1993, V. Furlan leg.

Coriomeris hirticornis (Fabricius, 1794)
Montandon, 1886: Gorica; Reuter, 1888: Gorica
Specimens examined:
Istra: Dragonja, Stena, UL93, 6. 5. 2000, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 1. 8. 2004, A. & M. Gogala leg.

Loxocnemis dentator (Fabricius, 1794)
A. & M. Gogala, 1986, 1994
Specimen examined:
Istra: Sočerga, VL13, 26. 7. 1984, A. & M. Gogala leg.

Nemocoris falleni R.F. Sahlberg, 1848
A. & M. Gogala, 1989
Specimen examined:
Matajur, 1642 m, UM81, 28. 6. 1987, A. & M. Gogala leg.

Ulmicola spinipes (Fallén, 1807)
Gogala & Moder, 1960: Ljubljana, Nanos; A. & M. Gogala, 1986, 1989; Protić, 1987: Podčetrtek
Specimens examined:
Tržič, Visoče, VM43, 1. 5. 1978, A. & M. Gogala leg.
Ljubljana: Savlje, VM60, 13. 3. 1983, 11. 4. 1988, A. & M. Gogala leg.
Ljubljansko barje: Log, Lukovica, VL59, 15. 5. 1985, A. & M. Gogala leg.
Čaven, VL08, 11. 6. 1988, A. & M. Gogala leg.
Lenart, Cerkvenjak, WM75, 31. 7. 2005, D. Fekonja leg.
Ljubljana, Golovec: Orle, VL69, 20. 5. 1984, 13. 5. 1991, V. Furlan leg.
Novo mesto, Trška gora, WL17, 21. – 22. 5. 1983, 6. 6. 1987, V. Furlan leg.
Topol, Osredek, VM50, 3. 6. 1984, 12. 5. 1985, V. Furlan leg.
Polhograjsko hrib.: Grmada, VM40, 9. 5. 1987, V. Furlan leg.
Podkum, WM00, 24. 5. 1989, V. Furlan leg.

Leptoglossus occidentalis Heidemann, 1910
M. Gogala, 2003; A. Gogala, 2003a; Jurc & Jurc, 2005: Manče (VL17), Kanal ob Soči (UM90), Žiri (VM30), Ljubljana: Gozdarski inštitut (VM50)
Specimens examined:
Kras: Brje pri Komnu, VL07, 21. 9. 2003, 27. 9. 2003, 11. 10. 2003, A. & M. Gogala leg.
Vipavska dol.: Ajdovščina, VL18, 17. 11. 2004, Š. Ambrožič leg.
Istra: Strunjan, UL94, 10. 12. 2004, M. Gogala leg.
Bohinj: Ukanc, VM12, 8. 10. 2004, A. Kajzer leg.
Additional record:
Godovič, 600 m, VL39, 9. 2004, 20. 1. 2005, P. Grošelj vid.

Centrocoris spiniger (Fabricius, 1781)
Gogala & Moder, 1960: Piran; Gogala, 1991
Specimens examined:
Portorož, UL94, 1. 10. 1987, A. & M. Gogala leg.
Istra: Padna, UL93, 17. 6. 1995, A. & M. Gogala leg.
Sečovlje, Fontanigge, UL93, 30. 7. 1997, A. & M. Gogala leg.

Centrocoris variegatus Kolenati, 1845
A. & M. Gogala, 1986, 1989; A. Gogala, 1992
Specimens examined:
Istra: Strunjan, UL94, 1. 7. 1979, A. & M. Gogala leg.
Portorož, Lucija, UL94, 2. 7. 1983 on *Beta maritima*, A. & M. Gogala leg.

Coreus marginatus (Linnaeus, 1758)
Scopoli, 1763: Carniola; Montandon, 1886: Gorica; Gogala & Moder, 1960; A. & M. Gogala, 1986, 1989, 1994; Protić, 1987: Podčetrtek
Specimens examined:
Radovljica, Lancovo, VM33, 4. 8. 1929, Staudacher leg.
Laibach (= Ljubljana), 9. 9. 1928, 14. 10. 1928, 3. 8. 1929, Staudacher leg.
Billichgraz (= Polhov Gradec), VM40, 9. 9. 1934, Staudacher leg.
Pokojišče, VL48, 24. 6. 1977, A. & M. Gogala leg.
Radovljica, Brezje, VM43, 24. 4. 1979, A. & M. Gogala leg.
Ig, Kremenica, VL68, 6. 9. 1975, 6. 6. 1976, 26. 6. 1976, S. Brelih leg.
Kamnik pod Krimom, Ponikve, VL58, 20. 6. 1982, A. & M. Gogala leg.
Ljubljansko barje: Bevke, VL59, 17. 4. 1983, A. & M. Gogala leg.
Goričko: Gornji Petrovci, WM98, 1. 5. 1983, A. & M. Gogala leg.

Prekmurje: Dobrovnik, Bukovniško jezero, XM07, 30. 4. 1983, A. & M. Gogala leg.
Sežana, VL16, 8. 6. 1983, A. & M. Gogala leg.
Postojna, Zagon, VL37, 21. 9. 1983, A. & M. Gogala leg.
Sorica, Soriška planina, VM22, 23. 6. 1984, A. & M. Gogala leg.
Istra: Boršt, VL03, 3. 5. 1986, A. & M. Gogala leg.
Čatež ob Savi, WL48, 6. 5. 1986, M. Gogala leg.
Vuhred, Hudi kot, WM15, 2. 6. 1986, M. Gogala leg.
Sečovlje, UL93, 7. 8. 1986, A. & M. Gogala leg.
Velike Bloke, VL57, 19. 4. 1987, A. & M. Gogala leg.
Veržej, WM86, 13. 6. 1987, A. & M. Gogala leg.
Korovci, WM77, 14. 6. 1987, A. & M. Gogala leg.
Portorož, UL94, 1. 10. 1987, A. & M. Gogala leg.
Idrija, Krekovše, VL19, 28. 6. 1988, M. Gogala leg.
Koštabona, Supotski slap, VL03, 12. 10. 1988, A. & M. Gogala leg.
Movraž, Movraška vala, VL13, 18. 5. 1990, A. & M. Gogala leg.
Kraški rob: Bezovica, VL14, 3. 10. 1990, A. & M. Gogala leg.
Prekmurje: Muriša, XM24, 1. 6. 1997, S. Gomboc leg.
Petišovci, XM15, 10. 4. 1997, S. Brelih leg.
Istra: Popetre, VL13, 9. 7. 1997, S. Brelih leg.
Koper, Škocjanski zatok, VL04, 23. 5. 2000, S. Brelih leg.
Lenart, Cerkvenjak, WM75, 12. 8. 2005, D. Fekonja leg.
Krško, Leskovec, WL38, 18. 6. 2005, D. Fekonja leg.
Ljubljana: Vič, VL59, 31. 8. 2005, D. Fekonja leg.
Kras: Lipica, VL15, 30. 5. 1982, V. Furlan leg.
Gorjanci: Jugorje, WL16, 27. 4. 1983, V. Furlan leg.
Bela krajina: Podzemelj, WL25, 28. 4. 1983, V. Furlan leg.
Vinica, WL13, 29. 4. 1983, V. Furlan leg.
Semič, WL15, 30. 4. 1983, V. Furlan leg.
Suha krajina: Žvirče, VL87, 7. 5. 1983, V. Furlan leg.
Radovna, VM24, 14. 5. 1983, V. Furlan leg.
Novo mesto, Trška gora, WL17, 21. – 22. 5. 1983, V. Furlan leg.
Topol, Osredek, VM50, 3. 6. 1984, V. Furlan leg.
Planinsko polje: Laze, VL47, 8. 6. 1984, V. Furlan leg.
Ratitovec, Prtovč, VM32, 10. 6. 1984, V. Furlan leg.
Kum, 1000 m, WM00, 7. 5. 1989, V. Furlan leg.
Sočerga, Mlini, Veli Badin, VL13, 12. 6. 1990, V. Furlan leg.
Additional record:
Brje pri Komnu, VL07, 30. 7. 2000 on *Solanum*, photo A. Gogala

Enoplops scapha (Fabricius, 1794)
Coreus scapha var. *illyricus* Horváth, 1887
Horváth, 1887a: Gorica – type locality of var. *illyricus*; Gogala & Moder, 1960: Cerknica, Rakitna; A. & M. Gogala, 1986, 1989
Specimens examined:
Ig, Kremenica, VL68, 28. 9. 1975, 1. 8. 1976, S. Brelih leg.
Logatec, VL48, 13. 4. 1980, A. & M. Gogala leg.
Velike Lašče, VL77, 25. 5. 1980, A. & M. Gogala leg.
Slavnik, VL14, 2. 6. 1984, A. & M. Gogala leg.
Ljubljansko barje: Ig, VL69, 4. 5. 1985, A. & M. Gogala leg.
Vipavska brda: Gaberje, Avša, VL17, 23. 5. 1993, A. Gogala leg.
Pokojišče, VL48, 24. 8. 1996, A. Gogala leg.
Žužemberk, Brinova Gora, 380 m, VL97, 8. 5. 2002, S. Brelih leg.
Krim, 900 m, VL58, 22. 5. 1986, V. Furlan leg.
Ljubljana, Golovec: Orle, VL69, 22. 3. 1989, V. Furlan leg.
Novo mesto, Trška gora, WL17, 6. 6. 1987, 16. 6. 1991, 7. 5. 1992, V. Furlan leg.
Ljubljana: Ježica, VM60, 12. 6. 1991, V. Furlan leg.
Additional record:
Ljubljana, Črnuče, Jarški prod, VM60, 17. 6. 2004, photo A. Gogala

Haploprocta sulcicornis (Fabricius, 1794)
Gogala & Moder, 1960: Carniola, F.J. Schmidt leg.

Spathocera laticornis (Schilling, 1829)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Ljubljana, Ježica, Dobrova; A. & M. Gogala, 1986; Protić, 1987: Podčetrtek
Specimens examined:
Laibach (= Ljubljana), 22. 4. 1930, 3. 2. 1935, Staudacher leg.
Ljubljana: Ježica, VM60, 25. 5. 1930, Staudacher leg.
Ljubljana: Savlje, VM60, 18. 2. 1998, M. Gogala leg.
Ljubljansko barje: Ig, Kremenica, VL68, 6. 9. 1975, S. Brelih leg.
Vipava, Goče, VL17, 13. 8. 1987, S. Brelih leg.
Prekmurje: Gančani, WM96, 12. 6. 1993, S. Gomboc leg.
Polhograjsko hrib.: Topol, Osredek, VM50, 5. 5. 1990, V. Furlan leg.

Spathocera lobata (Herrich-Schaeffer, 1840)
A. & M. Gogala, 1986
Specimen examined:
Istra: Marezige, VL04, 7. 9. 1985, A. Gogala leg.

Syromastus rhombeus (Linnaeus, 1767)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Črnomelj, Črni Kal; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Bela krajina: Črnomelj, WL14, 7. 5. 1933, Staudacher leg.
Portorož, Beli Križ, UL84, 10. 10. 1984, M. Gogala leg.
Istra: Boršt, VL03, 3. 5. 1986, A. & M. Gogala leg.

Kras: Brje pri Komnu, VL07, 5. 5. 1989, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 1. 8. 1990, A. & M. Gogala leg.
Strunjan, UL94, 27. 6. 1995, A. & M. Gogala leg.
Murska Sobota, Bogojina, WM97, 13. 8. 2005, D. Fekonja leg.
Črni Kal, Črnotiče, VL14, 29. 4. 1990, V. Furlan leg.
Kozina, Prešnica, VL14, 22. 6. 1991, V. Furlan leg.

Gonocerus acuteangulatus (Goeze, 1778)
Gonocerus venator (Fabricius, 1794)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Ljubljana; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Laibach (= Ljubljana), 10. 7. 1929, 5. 9. 1930, Staudacher leg.
Ig, Draga, VL68, 15. 8. 1976, S. Brelih leg.
Portorož, UL94, 20. 9. 1978, A. & M. Gogala leg.
Ljubljansko barje: Log, Lukovica, VL59, 5. 7. 1977, A. & M. Gogala leg.
Prekmurje: Selo, WM97, 5. 7. 1980, A. & M. Gogala leg.
Kras: Štorje, VL16, 8. 6. 1983, A. & M. Gogala leg.
Brkini: Barka, VL25, 28. 7. 1984, A. & M. Gogala leg.
Ajdovščina, VL18, 2. 8. 1985, A. & M. Gogala leg.
Korovci, WM77, 14. 6. 1987, A. & M. Gogala leg.
Dragonja, Stena, UL93, 1. 10. 1987, A. & M. Gogala leg.
Ajdovščina, Planina, VL17, 15. 3. 1988, A. & M. Gogala leg.
Sp. Brnik, VM61, 7. 9. 1988, A. & M. Gogala leg.
Cerkniško jezero: Dolenje Jezero, VL56, 10. 9. 1988, A. & M. Gogala leg.
Istra: Koštabona, Supotski slap, VL03, 12. 10. 1988, A. & M. Gogala leg.
Brje pri Komnu, VL07, 30. 7. 1989, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 18. 5. 1990, A. & M. Gogala leg.
Osp, VL14, 8. 7. 1990, A. & M. Gogala leg.
Cerkniško jezero: Otok, VL56, 15. 9. 1999, A. Gogala leg.
Komen, Branik, VL07, 27. 5. 1998, S. Brelih leg.
Ribnica, Sodražica, VL76, 25. 6. 2005, D. Fekonja leg.
Lenart, Cerkvenjak, WM75, 12. 8. 2005, D. Fekonja leg.
Slavnik, Podgorje, VL14, 3. 5. 1980, V. Furlan leg.
Trnovski gozd: Trnovo, 788 m, VL09, 18. 5. 1979, M. Zdešar leg.
Ig, Iška vas, VL68, 10. 6. 1989, V. Furlan leg.
Ljubljana, VM60, 19. 7. 1988, V. Furlan leg.

Gonocerus juniperi Herrich-Schaeffer, 1839
Gogala & Moder, 1960: Bohinj; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Bela krajina: Vinica, Zilje, WL23, 13. 9. 1981, A. & M. Gogala leg.
Bohinj: Stara Fužina, VM12, 27. 3. 1977, A. & M. Gogala leg.
Črni Kal, VL14, 28. 6. 1980, 17. 2. 1988, A. & M. Gogala leg.
Kamnik pod Krimom, 2 km S, VL58, 4. 10. 1981, A. & M. Gogala leg.
Brkini: Barka, VL25, 28. 7. 1984, A. & M. Gogala leg.
Strunjan, UL94, 16. 10. 1985, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 10. 9. 1988, A. & M. Gogala leg.
Kras: Štorje, VL16, 26. 3. 1989, A. & M. Gogala leg.
Brje pri Komnu, VL07, 7. 9. 1989, 1. 3. 1997, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 3. 10. 1990, A. & M. Gogala leg.
Gorjansko, UL97, 22. 2. 1992, A. & M. Gogala leg.
Istra: Padna, UL93, 1. 2. 1997, A. & M. Gogala leg.
Prekmurje: Lendava, Dolga vas, XM16, 1. 11. 1991, S. Gomboc & D. Kofol leg.
Kozina, Petrinje, VL14, 30. 4. 1980, M. Zdešar leg.

CYDNIDAE

Cydnus aterrimus (Forster, 1771)
Horváth, 1887a: Gorica; Gogala & Moder, 1960: Ig, Črni Kal; A. & M. Gogala, 1986, 1994
Specimens examined:
Ljubljansko barje: Ig, VL69, 4. 8. 1938, Staudacher leg.
Portorož, Lucan, UL94, 27. 4. 1999, A. Kapla leg.
Istra: Osp, VL14, 5. 6. 2001, A. Gogala leg.
Kras: Gorjansko, VL07, 2. 7. 2006, A. Gogala leg.

Geotomus elongatus (Herrich-Schaeffer, 1840)
Specimen examined:
Istra: Koper, Škocjanski zatok, 5 m, VL04, 26. 9. 2001, A. Pirnat leg.

Microporus nigrita (Fabricius, 1794)
Gogala & Moder, 1960: Ljubljana; Gogala, 1991
Specimens examined:
Laibach (= Ljubljana), 18. 9. 1925, 26. 4. 1931, Staudacher leg.
Podčetrtek, WM41, 27. 5. 1933, E. Jaeger leg.

Adomerus biguttatus (Linnaeus, 1758)
Scopoli, 1763: Carniola; Horváth, 1887a: Gorica; Gogala & Moder, 1960: Ljubljana, Črnuče, Ig, Bohinj, Rakek, Verd; A. & M. Gogala, 1986, 1989, 1994; Protić, 1987: Podčetrtek
Specimens examined:
Laibach (= Ljubljana), 30. 3. 1929, Staudacher leg.
Ljubljana: Ježica, VM60, 25. 5. 1930, Staudacher leg.
Vrhnika, Verd, VL49, 6. 9. 1940, Staudacher leg.
Ig, VL69, 25. 6. 1939, Staudacher leg.
Ljubljana, Črnuče, VM60, 25. 6. 1933, Staudacher leg.
Domžale, Dob, VM71, 24. 7. 1982, A. & M. Gogala leg.

Ljubljana, 8. 1. 1978, A. & M. Gogala leg.
Bohinj: Ukanc, VM02, 3. 7. 1978, A. & M. Gogala leg.
Ljubljana, Tacen, VM50, 2. 3. 1980, A. & M. Gogala leg.
Rakitna, VL58, 28. 6. 1981, A. & M. Gogala leg.
Bloke: Nova vas, VL66, 28. 6. 1981, A. & M. Gogala leg.
Bohinjska Bistrica, Nemški rovt, VM22, 15. 8. 1981, A. & M. Gogala leg.
Kras: Senožeče, VL26, 28. 6. 1982, A. & M. Gogala leg.
Vrhnika, VL49, 11. 7. 1982, A. & M. Gogala leg.
Podgorski kras: Petrinje, VL14, 8. 6. 1983, A. & M. Gogala leg.
Ljubljana: Savlje, VM60, 10. 6. 1983, A. & M. Gogala leg.
Ilirska Bistrica, Jelšane, VL43, 21. 6. 1983, M. Gogala leg.
Pohorje: Lovrenška jezera, WM24, 23. 8. 1987, A. & M. Gogala leg.
Ljubljansko barje: Log, Lukovica, VL59, 12. 9. 1987, A. & M. Gogala leg.
Idrija, Krekovše, VL19, 28. 6. 1983, M. Gogala leg.
Šmarje pri Jelšah, WM42, 17. 8. 1988, A. & M. Gogala leg.
Idrija, Godovič, VL39, 10. 7. 1989, M. Gogala leg.
Črnotiče, VL14, 18. 3. 1990, A. & M. Gogala leg.
Obrov, Golac, VL24, 8. 6. 2000, S. Brelih leg.
Litija, VM80, 21. 6. 1975, V. Furlan leg.
Savinjske Alpe: Smrekovec, VM94, 26. 6. 1987, B. Drovenik leg.
Gornji Ig, VL68, 23. 5. 1987, V. Furlan leg.
Novo mesto, Trška gora, WL17, 6. 6. 1987, V. Furlan leg.
Pohorje: Ribniški vrh (= Jezerski vrh), 1500 m, WM25, 16. 8. 1989, V. Furlan leg.
Ljubljana, Golovec, VL69, 3. 1989, V. Furlan leg.
Luče, Veža, Planica, VM73, 7. 1983, B. Drovenik leg.

Canthophorus dubius (Scopoli, 1763)
Montandon, 1886: Gorica; Gogala & Moder, 1960 (confused with *C. impressus);* A. & M. Gogala, 1986, 1994
Specimens examined:
Črni Kal, VL14, 10. 1969, M. Gogala leg.
Sevnica, Studenec, WL29, 5. 6. 1978
Brkini: Barka, VL25, 28. 7. 1984, A. & M. Gogala leg.
Brje pri Komnu, VL07, 5. 5. 1989, 16. 7. 1989, 21. 7. 1990, A. & M. Gogala leg.
Črnotiče, VL14, 18. 3. 1990, 8. 7. 1990, A. & M. Gogala leg.
Slavnik, VL14, 23. 6. 1991, A. & M. Gogala leg.
Vremščica, VL26, 4. 7. 1992, A. & M. Gogala leg.
Istra: Topolovec, VL03, 9. 5. 1991, A. & M. Gogala leg.
Zazid, Golič, 880 m, VL13, 17. 6. 2000, A. Gogala leg.
Zazid, Lipnik, VL13, 16. 6. 2001, A. Gogala leg.
Nanos, VL27, 2. 6. 1974, 18. 5. 1975, V. Furlan leg.
Črni Kal, Socerb, VL14, 8. 5. 1990, V. Furlan leg.
Črni Kal, Praproče, VL14, 12. 7. 1990, V. Furlan leg.
Sežana, Štorje, VL16, 16. 5. 1984, V. Furlan leg.
Kras: Povir, VL16, 16. 5. 1984, V. Furlan leg.

Canthophorus impressus (Horváth, 1880)
A. & M. Gogala, 1986
Specimens examined:
Topol, Sv. Katarina, VM50, 19. 6. 1932, Staudacher leg.
Bohinj: pl. Vogar, VL12, 2. 6. 1939, M. Hafner leg.
Bohinj: Ukanc, VM02, 22. 5. 1977, A. & M. Gogala leg.
Podljubelj, VM43, 25. 6. 1978
Sevnica, Studenec, WL29, 5. 6. 1978
Bloke: Nova vas, VL66, 28. 6. 1981, A. & M. Gogala leg.
Polhograjsko hrib.: Črni Vrh, VM40, 21. 6. 1984, A. & M. Gogala leg.
Trenta: Alpinetum Julijana, VM04, 2. 6. 1990, A. & M. Gogala leg.
Julijske Alpe: Komna, VM02, 7. 7. 1983, A. & M. Gogala leg.
Nanos: Pleša, VL27, 25. 7. 1992, A. & M. Gogala leg.
Ratitovec, VM32, 1. 7. 1995, A. Gogala leg.
Rakitna, VL58, 26. 5. 1998, A. Gogala leg.
Mrzlica, 1100 m, WM01, 25. 6. 1991, V. Furlan leg.
Bovec, Plužna, UM83, 13. 5. 1998, S. Brelih leg.
Javorniki: Lonica, VL46, 16. 5. 1976, V. Furlan leg.
Krim, Gornji Ig, VL68, 17. 5. 1981, V. Furlan leg.
Krim, VL58, 22. 5. 1989, V. Furlan leg.
Kamniška Bistrica, VM63, 7. 6. 1981, V. Furlan leg.
Unec, VL47, 25. 5. 1985, V. Furlan leg.

Canthophorus melanopterus (Herrich-Schaeffer, 1835)
Montandon, 1886: Gorica; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Kubed, VL14, 24. 7. 1984, A. & M. Gogala leg.
Črni Kal, VL14, 17. 6. 1986, A. & M. Gogala leg.
Labor, VL03, 9. 9. 1987, A. Gogala leg.
Sočerga, Veli Badin, VL13, 18. 5. 1990, 3. 10. 1990, A. & M. Gogala leg.
Črnotiče, VL14, 8. 7. 1990, A. & M. Gogala leg.
Istra: Topolovec, VL03, 9. 5. 1991, A. & M. Gogala leg.
Ajdovščina, Gradišče, VL18, 20. 6. 1998, A. Gogala leg.
Kraški rob: Podpeč, 320 m, VL14, 27. 5. 2001, A. Kapla leg.
Hrpelje, Prešnica, VL14, 23. 5. 1999, S. Brelih leg.
Osp, VL14, 20. 8.. 1998, S. Gomboc & D. Kofol leg., 14. 6. 1981, V. Furlan leg.
Brežec pri Podgorju, VL14, 16. 5. 1990, V. Furlan leg.
Additional record:
Kras: Brje pri Komnu, VL07, 23. 10. 2004 on *Thesium*, photo A. Gogala

Legnotus limbosus (Geoffroy, 1785)
Gnathoconus albomarginatus (Goeze, 1778)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Ježica, Ig; A. & M. Gogala, 1986, 1989
Specimens examined:
Ig, Iška, VL68, 11. 6. 1933, Staudacher leg.
Ig, VL69, 9. 6. 1940, Staudacher leg.
Ljubljana: Ježica, VM60, 27. 5. 1937, Staudacher leg.
Ljubljansko barje: Log, Lukovica, VL59, 30. 5. 1983, A. & M. Gogala leg.
Ljubljana: Savlje, VM60, 19. 4. 1984, A. & M. Gogala leg.
Škocjan, Naklo, desni breg Reke, VL25, 11. 10. 2001, A. Pirnat leg.
Dolnje Ležeče, VL25, 11. 10. 2001, A. Pirnat leg.
Kras: Brje pri Komnu, VL07, 30. 5. 2004, M. Gogala leg.
Prekmurje: Petišovci, XM15, 10. 4. 1997, S. Brelih leg.
Apače, Podgorje, Zg. Konjišče, WM67, 16. 6. 1994, B. Drovenik leg.
Radenci, Šratovci, Črna mlaka, WM76, 30. 3. 1994, B. Drovenik leg.
Hrastje-Mota, WM86, 24. 5. 1994, B. Drovenik leg.
Nova Gorica, Panovec, UL98, 15. 5. 2000, S. Brelih leg.
Osp, VL14, 18. 5. 1999, S. Gomboc & D. Kofol leg.
Nanos, VL27, 18. 5. 1975, V. Furlan leg.
Ljubljana, Golovec: Orle, VL69, 23. 4. 1983, V. Furlan leg.
Bela krajina: Podzemelj, WL25, 28. 4. 1983, V. Furlan leg.

Legnotus picipes (Fallén, 1807)
Gogala & Moder, 1960: Ljubljansko barje; A. & M. Gogala, 1986, 1994
Specimens examined:
Bohinj: Ukanc, VM02, 3. 7. 1978, A. & M. Gogala leg.
Kras: Štorje, VL16, 22. 7. 1980, A. & M. Gogala leg.
Brje pri Komnu, VL07, 12. 6. 1989, 31. 5. 1993, M. Gogala leg.
Slavnik, VL14, 19. 6. 1995, M. Gogala leg.
Kum, WM00, 26. 7. 1996, A. & M. Gogala leg.
Črni Kal, VL14, 28. 6. 1980, 11. 6. 1981, A. & M. Gogala leg.
Trstelj, UL98, 1. 7. 2001, A. & M. Gogala leg.
Bistrica ob Sotli, WM50, 10. 6. 1993, V. Furlan leg.
Ig, Matena, VL69, 24. 4. 1999, S. Brelih leg.
Podsreda, Trebča Gorca, WM40, 18. 5. 2000, S. Brelih leg.
Bovec, Kanin, UM83, 18. 7. 2000, S. Brelih leg.
Senožeče, Gabrče, VL26, 26. 5. 1987, V. Furlan leg.
Ljubljana: Dobrunje, Urh, VL69, 25. 6. 1997, V. Furlan leg.
Kozina, VL15, 22. 6. 1991, V. Furlan leg.
Sp. Šklendrovec, WM00, 30. 5. 1991, V. Furlan leg.

Ochetostethus opacus (Scholtz, 1847)
? Montandon, 1886: Gorica (as *O. nanus);* Kerzhner, 1976: Topla

Sehirus luctuosus Mulsant & Rey, 1866
Gogala & Moder, 1960: Ljubljana, Bohinj, Log v Trenti; A. & M. Gogala, 1986, 1989
Specimens examined:
Laibach (= Ljubljana), 19. 5. 1913, Stussiner leg., 12. 8. 1930, Staudacher leg.
Bohinj: Ribčev laz, VM12, 10. 9. 1932, M. Hafner leg.
Ljubljana, Tacen, VM50, 10. 1978, M. Gogala leg.
Ig, Golo, VL68, 1. 5. 1981, S. Brelih leg.
Polhograjsko hrib.: Topol, Sv. Katarina, VM50, 21. 4. 1983, M. Gogala leg.
Sorica, Soriška planina, VM22, 23. 6. 1984, A. & M. Gogala leg.
Kum: Ključevica, WM00, 8. 5. 1998, A. & M. Gogala leg.
Ig, Kurešček, VL68, 2. 5. 1999, A. & M. Gogala leg.
Mali Kum, 813 m, WM00, 6. 5. 1988, V. Furlan leg.
Ljubljana, Lavrica, VL69, 20. 5. 1991, V. Furlan leg.
Polhov Gradec, VM40, 6. 5. 1984, V. Furlan leg.
Selška dolina: Selca, VM32, 22. 7. 1987, V. Furlan leg.
Additional record:
Topol, Grmada, VM40, 27. 4. 2007, photo A. Gogala

Tritomegas bicolor (Linnaeus, 1758)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Ljubljana, Domžale, Radovna, Mavrlen; A. & M. Gogala, 1986; Gogala & Hočevar, 1990
Specimens examined:
Laibach (= Ljubljana), 12. 4. 1928, 20. 10. 1928, Staudacher leg.
Ljubljana: Savlje, VM60, 5. 3. 1977, A. & M. Gogala leg.
Ljubljana: Kleče, VM60, 8. 4. 2005, M. Gogala leg.
Log, Lukovica, VL59, 18. 6. 1978, A. & M. Gogala leg.
Moravče, Limbarska gora, VM81, 10. 2. 1980, A. & M. Gogala leg.
Ig, Kremenica, VL68, 30. 4. 1981, S. Brelih leg.
Polhograjsko hrib.: Topol, Sv. Katarina, VM50, 21. 4. 1983, M. Gogala leg.
Ljubljansko barje: Drenov grič, VL49, 18. 2. 1989, M. Gogala leg.
Brezovica, VL59, 9. 4. 1983, A. & M. Gogala leg.
Dolina Raše: Griže, VL16, 21. 3. 1992, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 12. 3. 1995, 31. 3. 1997, A. & M. Gogala leg.
Prekmurje: Bukovnica, XM07, 23. 2. 1997, S. Gomboc leg.
Pragersko, WM53, 9. 2. 1974, V. Furlan leg.
Vipava, VL17, 27. 2. 1974, V. Furlan leg.
Vipava, Erzelj, VL17, 22. – 30. 9. 1972, B. Drovenik leg.

Topol, Osredek, VM50, 12. 5. 1985, V. Furlan leg.
Unec, VL47, 10. 5. 1987, V. Furlan leg.
Mali Kum, 813 m, WM00, 6. 5. 1988, V. Furlan leg.
Dolenjska: Šmarjeta, WL18, 3. 5. 1997, V. Furlan leg.
Kočevje, Livold, Rinža, VL95, 15. 6. 1993, V. Furlan leg.
Ljubljana, Golovec: Orle, VL69, 13. 5. 1991, V. Furlan leg.
Novo mesto, Trška gora, WL17, 11. 6. 1992, V. Furlan leg.
Gornji Ig, VL68, 14. 5. 1991, V. Furlan leg.

Tritomegas rotundipennis (Dohrn, 1862)
A. & M. Gogala, 1989; Gogala & Hočevar, 1990
Specimens examined:
Bevke, VL59, 27. 3. 1982, A. & M. Gogala leg.
Ljubljansko barje: Plešivica, VL59, 11. 3. 1983, A. & M. Gogala leg.
Log, Lukovica, VL59, 11. 4. 1987, A. & M. Gogala leg.
Velike Bloke, VL57, 19. 4. 1987, A. & M. Gogala leg.
Kras: Veliki Dol, VL07, 22. 3. 1992, A. & M. Gogala leg.
Kregolišče, VL07, 19. 4. 1992, A. & M. Gogala leg.
Divača, Famlje, VL25, 18. 3. 1994, A. & M. Gogala leg.
Zadlog, Drgota, 720 m, VL28, 29. 5. 1999, A. & M. Gogala leg.
Bovec – Plužna, 520 m, UM83, 29. 5. 2001, S. Brelih leg.
Vrhe: Stomaž, VL17, 9. 2. 2008, A. Gogala leg.
Ljubljana: Zadvor, VL69, 5. 5. 1974, V. Furlan leg.
Nanos, VL27, 2. 6. 1974, V. Furlan leg.
Rakov Škocjan, 500 m, VL47, 12. 4. 1975, V. Furlan leg.
Bela krajina: Črnomelj, Veliki Nerajec, WL14, 29. 4. 1983, V. Furlan leg.
Škofja Loka, Lubnik, 1025 m, VM41, 4. 4. 1981, V. Furlan leg.

Tritomegas sexmaculatus (Rambur, 1839)
Scopoli, 1763 (as *C. bicolor):* "In monticulis Adriatico mari proximis" – In the hills near the Adriatic Sea (Italy or Slovenia); A. & M. Gogala, 1986, 1994; Gogala & Hočevar, 1990
Specimens examined:
Istra: Piran, UL84, 15. 4. 1979, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 3. 10. 1990, A. & M. Gogala leg.
Koper, Bonifika, 10 m, VL04, 26. 9. 2001, A. Pirnat leg.
Kozina, VL15, 22. 6. 1991, V. Furlan leg.
Note: Scopoli (1763) listed *Cimex bicolor* L., although he noticed differences from the Swedish specimens: "Bicolor Svecicus antice ad marginem thoracis utrinque maculam albam habet, noster vero marginem eundem album" – Swedish bicolor has a white spot frontally at the margin of thorax (pronotum), while in our bicolor the whole margin is white. Undoubtedly, he was dealing with *T. sexmaculatus*, but did not dare to describe it as a new species.

THYREOCORIDAE

Thyreocoris scarabaeoides (Linnaeus, 1758)
Gogala & Moder, 1960: Ljubljana, Mavrlen, Ljubljanski grad; A. & M. Gogala, 1986, 1989
Specimens examined:
Laibach (= Ljubljana), 29. 9. 1928, Staudacher leg.
Ljubljana, 2. 1973, M. Gogala leg.
Ljubljana: Savlje, VM60, 19. 4. 1984, A. & M. Gogala leg.
Cerkniško jezero: Dolenje Jezero, VL56, 15. 7. 2005, A. Gogala leg.
Ljubljana, Golovec: Orle, VL69, 23. 4. 1983, 21. 4. 1985, V. Furlan leg.
Polhograjsko hrib.: Topol, Osredek, VM50, 12. 5. 1985, V. Furlan leg.
Gornji Ig, VL68, 23. 5. 1987, V. Furlan leg.

PLATASPIDAE

Coptosoma scutellatum (Geoffroy, 1785)
Coptosoma globus (Fabricius, 1794)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Ljubljana, Dobrova, Podutik, Ihan, Zagorje, Dolenjske Toplice, Trojane, Koper; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Zagorje ob Savi, WM01, 14. 7. 1935, Staudacher leg.
Dolenjske Toplice, WL06, 22. 7. 1934, Staudacher leg.
Ljubljana: Ježica, VM60, 8. 6. 1930, Staudacher leg.
Laibach (= Ljubljana), 1. 7. 1939, Staudacher leg.
Posavje (Ljubljana: Roje), VM60, 5. 7. 1954, M. Gogala leg.
Ljubljansko barje: Log, Lukovica, VL59, 24. 6. 1979, A. & M. Gogala leg.
Ig, Kremenica, VL68, 26. 6. 1976, 11. 7. 1976, 11. 7. 1979, S. Brelih leg.
Štorje, VL16, 22. 7. 1980, A. & M. Gogala leg.
Koštabona, VL03, 25. 6. 1981, M. Gogala leg.
Kozina, VL15, 5. 8. 1981, A. & M. Gogala leg.
Bela krajina: Vinica, Zilje, WL23, 13. 9. 1981, A. & M. Gogala leg.
Ljubljana, Črnuče, VM60, 21. 6. 1982, A. & M. Gogala leg.
Medvode, Sora, Draga, VM51, 22. 7. 1982, A. & M. Gogala leg.
Domžale, Dob, VM71, 24. 7. 1982, A. & M. Gogala leg.
Ankaran, VL04, 8. 6. 1983, A. & M. Gogala leg.
Portorož, Lucija, UL94, 2. 7. 1983, A. & M. Gogala leg.
Ilirska Bistrica, Jelšane, VL43, 21. 6. 1983, M. Gogala leg.
Koper, Sermin, VL04, 16. 6. 1984, A. & M. Gogala leg.
Brkini: Barka, VL25, 28. 7. 1984, A. & M. Gogala leg.
Krka, VL88, 12. 8. 1984, A. & M. Gogala leg.
Podgorski kras: Petrinje, VL14, 11. 7. 1986, A. & M. Gogala leg.

Šmarje pri Jelšah, WM42, 17. 8. 1988, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 12. 6. 1989, M. Gogala leg.
Sočerga, Veli Badin, VL13, 9. 6. 1990, A. & M. Gogala leg.
Istra: Dragonja, Stena, UL93, 9. 6. 1990, A. & M. Gogala leg.
Koper, Bertoki, Škocjanski zatok, VL04, 7. 7. 2000, A. Gogala leg.
Zazid, Lipnik, 800 m, VL13, 17. 6. 2000, A. Gogala leg.
Haloze: Sedlašek, Cigler, 420 m, WM63, 18. 7. 2002, T. Trilar leg.
Podnanos, VL17, 18. 6. 1996, S. Gomboc leg.
Istra: Popetre, VL13, 9. 7. 1997, S. Brelih leg.
Nanos: južna pobočja, VL27, 13. 6. 1998, S. Gomboc leg.
Nova Gorica, Panovec, UL98, 6. 7. 2000, S. Brelih leg.
Ig, Iška vas, VL68, 10. 8. 1974, V. Furlan leg.
Slavnik, VL14, 9. 6. 1979, V. Furlan leg.
Muljava, VL88, 16. 7. 1976, V. Furlan leg.
Novo mesto, Trška gora, WL17, 21. – 22. 5. 1983, 6. 6. 1987, V. Furlan leg.
Povir, VL16, 31. 7. 1984, V. Furlan leg.
Brežec pri Podgorju, VL14, 16. 5. 1990, V. Furlan leg.
Kum, WM00, 20. 7. 1987, V. Furlan leg.
Radeče, Jagnjenica, WM00, 24. 5. 1990, V. Furlan leg.

ACANTHOSOMATIDAE

Acanthosoma haemorrhoidale (Linnaeus, 1758)
Gogala & Moder, 1960: Ljubljana, Krvavec, Planina, Lubnik; Balarin, 1962: Markovščina; A. & M. Gogala, 1986, 1989
Specimens examined:
Planina, VL47, 12. 6. 1927, Staudacher leg.
Krvavec, VM62, 23. 5. 1937, Staudacher leg.
Ljubljana, 15. 10. 1954, M. Gogala leg., VL69, 17. 9. 1995, V. Furlan leg.
Borovnica, VL58, 23. 6. 1979, A. & M. Gogala leg.
Borovnica, Pekel, VL58, 27. 4. 1988, A. & M. Gogala leg.
Ig, Draga, VL68, 29. 6. 1976, S. Brelih leg.
Goričko: Trdkova, WM89, 14. 6. 1987, A. & M. Gogala leg.
Prekmurje: Dolnja Bistrica, XM05, 23. 5. 1992, A. & M. Gogala leg.
Krn, 2245 m, UM92, 18. 6. 1995, D. Šere leg.
Podčetrtek, Vonarje, WM41, 6. 8. 1996, A. Gogala leg.
Vremščica, VL26, 2. 11. 1996, A. Gogala leg.
Čaven: Kucelj, VL08, 27. 6. 1998, A. & M. Gogala leg.
Hrastnik, Krnice, WM00, 6. 6. 2000, A. Kapla leg.
Mangart, Mangartsko sedlo, 1950 m, UM94, 22. 5. 2005, T. Trilar leg.
Novo mesto, Trška gora, WL17, 24. 6. 1996, V. Furlan leg.
Dolina pri Lendavi, XM15, 7. 6. 1998, S. Gomboc leg.
Prekmurje: Muriša, XM24, 16. 7. 1998, S. Gomboc leg.
Kamniško-Savinjske Alpe: Kamniško sedlo, VM63, 10. 6. 1972, V. Furlan leg.
Ljubljana, Golovec, VL69, 5. 4. 1981, 19. 4. 1981, V. Furlan leg.
Rogatec, Strmec, WM52, 16. 5. 1990, S. Brelih leg.

Cyphostethus tristriatus (Fabricius, 1787)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Bohinj; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Črni Kal, VL14, 10. 1976, M. Gogala leg., 28. 6. 1980, 17. 2. 1988, A. & M. Gogala leg.
Bohinj: Stara Fužina, VM12, 27. 3. 1977, A. & M. Gogala leg.
Pokojišče, VL48, 7. 9. 1981, A. & M. Gogala leg.
Bela krajina: Vinica, Zilje, WL23, 13. 9. 1981, A. & M. Gogala leg.
Kamnik pod Krimom, Ponikve, VL58, 4. 10. 1981, A. & M. Gogala leg.
Brkini: Barka, VL25, 28. 7. 1984, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 11. 7. 1987, 10. 9. 1988, A. & M. Gogala leg.
Štorje, VL16, 26. 3. 1989, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 18. 2. 1990, 3. 10. 1990, A. & M. Gogala leg.
Istra: Topolovec, VL03, 9. 5. 1991, A. & M. Gogala leg.
Kras: Gorjansko, UL97, 22. 2. 1992, M. Gogala leg.
Padna, UL93, 1. 2. 1997, A. & M. Gogala leg.
Dragonja, Pišine, UL93, 1. 2. 1997, A. & M. Gogala leg.
Brje pri Komnu, VL07, 1. 3. 1997, 9. 9. 2001 on *Juniperus,* A. Gogala leg.
Škocjan, r. Reka, VL25, 25. 8. 2001, A. Gogala leg.
Istra: Trebeše, VL13, 14. 4. 2007, A. & M. Gogala leg.
Loški potok, Retje, VL66, 14. 10. 1991, V. Furlan leg.
Additional records:
Stomaž, p. Kranjšek, VL17, 16. 4. 2005, photo A. Gogala
Komen, Vale, UL97, 18. 3. 2007, photo A. Gogala

Elasmostethus interstinctus (Linnaeus, 1758)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Kamn. Bistrica, Lubnik; A. & M. Gogala, 1986, 1989; Protić, 2001: Gorica
Specimens examined:
Polhograjsko hrib.: Črni Vrh, VM40, 10. 8. 1983, A. & M. Gogala leg.
Jezersko, VM64, 14. 8. 1983, A. & M. Gogala leg.
Podolševa, Žibovt – Kisla voda, VM74, 26. 6. 1988, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 10. 9. 1988, A. & M. Gogala leg.
Prekmurje: Mala Polana, Črni log, XM06, 23. 5. 1992, A. & M. Gogala leg.
Gančani, WM96, 27. 4. 1998, 30. 5. 1998, S. Gomboc leg.

Ljubljana, Golovec, VL69, 18. 10. 1975, 2. 4. 1981, 5. 4. 1981, 23. 4. 1983, V. Furlan leg.

Elasmostethus minor Horváth, 1899
Gogala & Moder, 1960: Bohinj; A. & M. Gogala, 1986, 1989; Protić, 1987: Podčetrtek
Specimens examined:
Škofja Loka, Lubnik, VM41, 2. 6. 1930, M. Hafner leg., 2. 7. 1933, Staudacher leg.
Bohinj: Ukanc, VM02, 15. 5. 1977, 22. 5. 1977, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 11. 7. 1987, A. & M. Gogala leg.
Logarska dolina, VM74, 25. 6. 1988, A. & M. Gogala leg.
Kras: Senadole, VL26, 1. 7. 1993, M. Gogala leg.
Cerkniško jezero: Zadnji kraj, VL56, 22. 8. 2004, A. Gogala leg.
Ljubljana, VM60, 8. 4. 1989, V. Furlan leg.

Elasmucha ferrugata (Fabricius, 1787)
Gogala & Moder, 1960: Selška dolina; Balarin, 1962: Hraše (Kranj); A. & M. Gogala, 1986; A. Gogala, 1992
Specimens examined:
Bohinj: Ukanc, VM02, 22. 5. 1977, A. & M. Gogala leg.

Elasmucha fieberi (Jakovlev, 1865)
Gogala, 1991
Specimen examined:
Kum, 1219 m, WM00, 20. 7. 1987, V. Furlan leg.

Elasmucha grisea (Linnaeus, 1758)
Gogala & Moder, 1960: Ljubljana, Pokojišče; A. & M. Gogala, 1986, 1989; Protić, 1987: Maribor
Specimens examined:
Pokojišče, VL58, 21. 7. 1929, 27. 4. 1930, 14. 5. 1931, Staudacher leg.
Laibach (= Ljubljana), 15. 8. 1940, Staudacher leg.
Škofja Loka, Sorško polje, VM51, 12. 6. 1921, M. Hafner leg.
Ljubljansko barje: Log, Lukovica, VL59, 18. 8. 1982, A. & M. Gogala leg.
Polhograjsko hrib.: Črni Vrh, VM40, 4. 8. 1983, A. & M. Gogala leg.
Brkini: Artviže, VL25, 28. 7. 1984, A. & M. Gogala leg.
Osilnica, Plešce, slov. stran reke, VL74, 27. 7. 1985, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 19. 4. 1987, 10. 9. 1988, A. & M. Gogala leg.
Podolševa, Žibovt – Kisla voda, VM74, 26. 6. 1988, A. & M. Gogala leg.
Slavnik, VL14, 23. 6. 1991, A. & M. Gogala leg.
Prekmurje: Dobrovnik, Bukovniško jezero, XM07, 23. 5. 1992, A. & M. Gogala leg.
Ljubljana, Golovec, VL69, 11. 5. 1980, V. Furlan leg.
Ig, VL69, 19. 4. 1980, V. Furlan leg.
Dobrova, VM50, 20. 4. 1979, V. Furlan leg.
Ljubljana: Nove Jarše, VM60, 16. 8. 1985, V. Furlan leg.
Krim, 950 m, VL58, 8. 5. 1987, V. Furlan leg.

SCUTELLERIDAE

Odontotarsus purpureolineatus (Rossi, 1790)
Montandon, 1886: Gorica (as *O. grammicus);* Gogala & Moder, 1960: Črni Kal; A. & M. Gogala, 1986, 1989, 1994; Protić, 1987: Podčetrtek
Specimens examined:
Črni Kal, VL14, 28. 6. 1980, A. & M. Gogala leg.
Koper, Sermin, VL04, 16. 6. 1984, A. & M. Gogala leg.
Sočerga, VL13, 26. 7. 1984, A. & M. Gogala leg.
Dragonja, Stena, UL93, 1. 10. 1987, 9. 6. 1990, A. & M. Gogala leg.
Šmarje pri Jelšah, WM42, 17. 8. 1988, A. & M. Gogala leg.
Brje pri Komnu, VL07, 28. 5. 1989, 20. 8. 1989, A. & M. Gogala leg.
Movraž, VL13, 14. 6. 1991, A. & M. Gogala leg.
Hrpelje, Prešnica, VL14, 22. 6. 1991, A. & M. Gogala leg., 7. 6. 1999, S. Brelih leg.
Otlica, Otliški maj, VL18, 14. 7. 2001, A. Gogala leg.
Ljubljana, Črnuče, Jarški prod, VM60, 23. 6. 2004, A. Gogala leg.
Nova Gorica, Sabotin, UL99, 9. 7. 1995, S. Gomboc leg.
Kozina, VL15, 22. 6. 1991, V. Furlan leg.
Branik, VL07, 14. 6. 1988, M. Zdešar leg.
Sočerga, Šeki, VL13, 17. 6. 1999, S. Brelih leg.
Sočerga, Mlini, Veli Badin, VL13, 12. 6. 1990, V. Furlan leg.
Novo mesto, Trška gora, WL17, 6. 6. 1987, V. Furlan leg.
Additional record:
Savinjske Alpe: Logarska dolina, 700 – 1100 m, VM74, 21. – 24. 6. 2005, J. Kolibáč leg.

Odontoscelis fuliginosa (Linnaeus, 1761)
Gogala & Moder, 1960: Zagorje; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Zagorje ob Savi, WM01, 12. 6. 1932, Staudacher leg.
Črni Kal, VL14, 7. 6. 1987, A. & M. Gogala leg.
Košuta: Pl. Šija, 1530 – 1800 m, VM44, 20. 8. 1991, A. & M. Gogala leg.
Čaven, Kucelj, 1237 m, VL08, 28. 8. 2004, A. Gogala leg.
Kraški rob: Rakitovec, Kavčič, VL23, 9. 6. 2007, A. Gogala leg.
Krško, Mrtvice, WL48, 3. 9. 2003, A. Kapla leg.
Additional record:
Savinjske Alpe: Logarska dolina, 700 – 1100 m, VM74, 21. – 24. 6. 2005, J. Kolibáč leg.

Odontoscelis lineola Rambur, 1839
Montandon, 1886: Gorica (as *O. dorsalis*); Gogala & Moder, 1960: Pokojišče (as *O. dorsalis*); Balarin, 1962: Slavina (as *O. dorsalis*); Gogala, 1991
Specimens examined:
Pokojišče, VL58, 21. 7. 1929, Staudacher leg.

Eurygaster austriaca (Schrank, 1776)
Gogala & Moder, 1960: Ljubljana; A. & M. Gogala, 1989 (as *E. hottentotta*); Gogala, 1991
Specimens examined:
Laibach (= Ljubljana), 17. 4. 1930, Staudacher leg.
Istra: Koštabona, VL03, 7. 6. 1987, A. & M. Gogala leg.

Eurygaster dilaticollis Dohrn, 1860
Eurygaster schreiberi Montandon, 1885
Montandon, 1885, 1886: Gorica – type locality of *E. schreiberi*; Gräffe, 1911: Gorica; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Pokojišče, VL58, 21. 7. 1929, Staudacher leg.
Pokojišče, VL48, 28. 6. 1978, A. & M. Gogala leg.
Podgorski kras: Petrinje, VL14, 15. 4. 1979, A. & M. Gogala leg.
Črni Kal, VL14, 1. 7. 1979, 28. 6. 1980, A. & M. Gogala leg.
Kras: Štorje, VL16, 8. 6. 1983, A. & M. Gogala leg.
Slavnik, VL14, 2. 6. 1984, A. & M. Gogala leg.
Brkini: Barka, VL25, 28. 7. 1984, A. & M. Gogala leg.
Čaven, VL08, 11. 6. 1988, 22. 8. 1992, A. & M. Gogala leg.
Brje pri Komnu, VL07, 16. 7. 1989, A. & M. Gogala leg.
Trstelj, UL98, 13. 8. 1989, A. & M. Gogala leg.
Ilirska Bistrica, Štanga, VL44, 3. 6. 2000, A. Gogala leg.
Hrpelje, Prešnica, VL14, 13. 7. 1998, S. Brelih leg.
Štorje, Senadolice, VL16, 22. 5. 1979, M. Zdešar leg.
Divača, VL26, 30. 5. 1982, V. Furlan leg.
Črni Kal, Praproče, VL14, 12. 7. 1990, V. Furlan leg.
Loški potok, VL66, 31. 7. 1997, V. Furlan leg.

Eurygaster maura (Linnaeus, 1758)
Scopoli, 1763: Carniola; Montandon, 1886: Gorica; Gogala & Moder, 1960: Ljubljana, Dol pri Lj., Dobrova, Utik, Cerkno; Balarin, 1962: Mežica, Hraše; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Medvode, Utik, VM61, 24. 8. 1928, Staudacher leg.
Ljubljansko barje: Log, Lukovica, VL59, 2. 6. 1978, A. & M. Gogala leg.
Koper, Škocjanski zatok, VL04, 1. 7. 1979, A. & M. Gogala leg.
Ljubljana, Tacen, VM50, 6. 3. 1983, A. & M. Gogala leg.
Istra: Sočerga, VL13, 26. 7. 1984, A. & M. Gogala leg.
Ljubljana: Savlje, VM60, 15. 4. 1987, A. & M. Gogala leg.
Izola, Šared, UL94, 11. 5. 1989, M. Gogala leg.
Dragonja, Stena, UL93, 17. 9. 1989, A. & M. Gogala leg.
Nanos: Šembijska bajta, VL27, 10. 8. 1996, A. & M. Gogala leg.
Sp. Branica, Čipnje, VL07, 1. 5. 2001, A. & M. Gogala leg.
Stična, VL89, 17. 3. 1974, V. Furlan leg.
Ljubljana, Golovec: Orle, VL69, 20. 5. 1984, V. Furlan leg.
Sočerga, Mlini, Veli Badin, VL13, 12. 6. 1990, V. Furlan leg.
Additional records:
Kočevje, Kočevski Rog, 450 – 550 m, VL96, 25. 6. 2005, J. Kolibáč leg.
Postojna env., 400 – 600 m, VL37, 27. – 28. 6. 2005, J. Kolibáč leg.

Eurygaster testudinaria (Geoffroy, 1785)
Gogala & Moder, 1960: Ljubljana, Bohinj, Šklendrovec, Dol pri Lj., Dobrova, Črni Kal; Balarin, 1962: Kokra; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Laibach (= Ljubljana), 1. 7. 1929, 10. 7. 1929, 14. 7. 1929, 20. 8. 1931, Staudacher leg.
Ig, VL69, 4. 8. 1938, Staudacher leg.
Bohinj: Ukanc, VM02, 3. 7. 1977, 24. 7. 1977, 24. 8. 1980, A. & M. Gogala leg.
Pokojišče, VL48, 23. 6. 1978, A. & M. Gogala leg.
Ljubljansko barje: Podpeč, VL59, 12. 7. 1977, A. & M. Gogala leg.
Medvode, Sora, Draga, VM51, 22. 7. 1982, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 7. 8. 1983, 19. 4. 1987, A. & M. Gogala leg.
Rakitna, VL58, 31. 7. 1984, A. & M. Gogala leg.
Rakitna, Pikovnik, VL58, 19. 4. 1987, A. & M. Gogala leg.
Horjul, Lesno brdo, VL49, 8. 6. 1986, A. & M. Gogala leg.
Cerkniško jezero: Dolenje Jezero, VL56, 24. 5. 1987, A. & M. Gogala leg.
Prekmurje: Gomilica, XM06, 13. 6. 1987, A. & M. Gogala leg.
Idrija, Krekovše, VL19, 28. 6. 1988, M. Gogala leg.
Šmarje pri Jelšah, WM42, 17. 8. 1988, A. & M. Gogala leg.
Sp. Brnik, VM61, 7. 9. 1988, A. & M. Gogala leg.
Trstelj, UL98, 13. 8. 1989, A. & M. Gogala leg.
Izvir Rižane, VL14, 18. 3. 1990, A. & M. Gogala leg.
Kum, WM00, 23. 7. 1997, A. Kapla leg.
Breginj – Logje, UM72, 12. 6. 1997, S. Brelih leg.
Gotenica, VL85, 4. 7. 1997, S. Brelih leg.
Ljubljana: Ježica, VM60, 12. 6. 1991, V. Furlan leg.
Hrpelje, Prešnica, VL14, 22. 6. 1991, V. Furlan leg.
Novo mesto, Trška gora, WL17, 11. 6. 1992, V. Furlan leg.

Ljubljana, Golovec: Orle, VL69, 20. 5. 1984, 13. 5. 1991, V. Furlan leg.
Dolina pri Lendavi, XM15, 31. 5. 1998, S. Gomboc leg.
Prekmurje: Bukovnica, XM07, 2. 6. 1999, S. Brelih leg.
Ilirska Bistrica, Zarečje – Brce, VL34, 31. 5. 1999, S. Brelih leg.
Nova Gorica, Panovec, UL98, 15. 5. 2000, S. Brelih leg.
Ljubljana: Tomačevski prod, VM60, 27. 7. 2005, D. Fekonja leg.
Ljubljana: Vič, VL59, 31. 8. 2005, D. Fekonja leg.
Bela krajina: Vinica, WL13, 29. 4. 1983, V. Furlan leg.
Unec, VL47, 9. 6. 1983, V. Furlan leg.
Sočerga, Mlini, Veli Badin, VL13, 16. 5. 1990, V. Furlan leg.
Selška dolina: Praprotno, VM41, 29. 5. 1987, V. Furlan leg.
Goričko: Dolič, WM88, 25. 5. 1989, S. Brelih leg.
Gorjanci: Sv. Miklavž, WL26, 29. 8. 1990, V. Furlan leg.
Borovnica, Pekel, VL58, 14. 8. 1990, S. Brelih leg.

Psacasta exanthematica (Scopoli, 1763)
Specimen examined:
Sela na Krasu, UL97, 18. 6. 2006 on *Onosma*, A. Gogala leg. (Fig. 1)
Additional record:
Izvir Rižane, VL14, 17. 9. 2005 on *Echium*, photo I. Sivec

PENTATOMIDAE

Asopinae

Arma custos (Fabricius, 1794)
Montandon, 1886: Gorica; Gräffe, 1911: Tolmin; Gogala & Moder, 1960: Ljubljana, Šentvid; A. & M. Gogala, 1986, 1989
Specimens examined:
Laibach (= Ljubljana), Staudacher leg.
Ljubljana: Šentvid, VM50, 17. 9. 1956, M. Gogala leg.
Prekmurje: Kobilje, XM07, 20. 5. 1970, B. Drovenik leg.
Bela krajina: Vinica, Zilje, WL23, 13. 9. 1981, A. & M. Gogala leg.
Prekmurje: Korovci, WM77, 14. 6. 1987, A. & M. Gogala leg.
Log, Lukovica, VL59, 30. 6. 1987, A. & M. Gogala leg.
Dobrovnik, Bukovniško jezero, XM07, 23. 5. 1992, A. & M. Gogala leg.
Ljubljansko barje: Bevke, VL59, 6. 9. 1996, A. & M. Gogala leg.
Log, Dragomer, VL59, 19. 4. 1997, A. Gogala leg.
Topol, Sv. Katarina, VM50, 15. 6. 1997, V. Furlan leg.
Ljubljana, Golovec, VL69, 22. 4. 1979, 8. 4. 1981, V. Furlan leg.
Ljubljana, Golovec: Orle, VL69, 13. 4. 1985, V. Furlan leg.

Jalla dumosa (Linnaeus, 1758)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Ljubljana; A. & M. Gogala, 1986
Specimens examined:
Laibach (= Ljubljana), 10. 11. 1930, Staudacher leg.
Julijske Alpe: Rombon – Pl. Goričica, UM83, 9. – 11. 6. 2000, A. Kapla leg.
Kras: Lipica, VL15, 19. 5. 1979, V. Furlan leg.

Picromerus bidens (Linnaeus, 1758)
Gogala & Moder, 1960: Ljubljana, Šmartno ob Savi, Vogel, Bohinj; A. & M. Gogala, 1986, 1989
Specimens examined:
Laibach (= Ljubljana), 11. 7. 1929, 15. 7. 1929, 3. 8. 1929, 15. 9. 1929, 5. 9. 1930, 20. 9. 1940, Staudacher leg.
Bohinj: Ukanc, VM02, 28. 8. 1977, 9. 8. 1978, A. & M. Gogala leg.
Ig, Kremenica, VL68, 14. 9. 1979, S. Brelih leg.
Ig, Draga, VL68, 8. 8. 1976, S. Brelih leg.
Ljubljansko barje: Bevke, VL59, 26. 8. 1980, A. & M. Gogala leg.
Jezersko, VM64, 14. 8. 1983, A. & M. Gogala leg.
Polhograjsko hrib.: Črni Vrh, VM40, 10. 8. 1983, A. & M. Gogala leg.
Šmarje pri Jelšah, WM42, 17. 8. 1988, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 10. 9. 1988, A. & M. Gogala leg.
Nanos: Pleša, VL27, 11. 9. 1999, A. Gogala leg.
Kras: Brje pri Komnu, VL07, 12. 9. 1999, 21. 9. 2003, A. & M. Gogala leg.
Senožeče, Gabrče, VL26, 4. 11. 1992, S. Gomboc & D. Kofol leg.
Cerknica, VL57, 3. 8. 1986, V. Furlan leg.
Bohinj, Pl. Vogar, VM12, 21. 9. 1991, V. Furlan leg.
Ljubljana, Golovec, VL69, 9. 10. 1995, V. Furlan leg.

Pinthaeus sanguinipes (Fabricius, 1781)
Gogala & Moder, 1960: Ljubljana, Črnuče; A. & M. Gogala, 1986, 1989
Specimens examined:
Podčetrtek, WM41, 7. 6. 1933, E. Jaeger leg.
Laibach (= Ljubljana), 15. 9. 1929, Staudacher leg.
Ljubljana, Črnuče, VM60, 16. 10. 1949, S. Brelih leg.
Ljubljana: Šiška, VM50, 19. 8. 1981, A. Gogala leg.
Ljubljansko barje: Log, Lukovica, VL59, 14. 5. 1983, 14. 5. 1987, A. & M. Gogala leg.
Prekmurje: Muriša, XM24, 7. 6. 1998, S. Gomboc leg.
Brezje pri Dobrovi, VL49, 20. 7. 1977, M. Zdešar leg.
Polhograjsko hrib.: Topol, VM50, 12. 11. 1983, B. Drovenik leg.

Rhacognathus punctatus (Linnaeus, 1758)
Gogala & Moder, 1960: Ljubljana, Nanos; A. & M. Gogala, 1986; Protić, 1987: Podčetrtek

Specimens examined:
Škofja Loka, Sorško polje, VM51, 12. 6. 1932, M. Hafner leg.
Laibach (= Ljubljana), 20. 10. 1928, 29. 6. 1929, 1. 7. 1939, 13. 7. 1939, Staudacher leg.
Ig, Kremenica, VL68, 19. 6. 1976, S. Brelih leg.
Ig, Draga, VL68, 11. 7. 1976, S. Brelih leg.
Velike Lašče, Rašica, VL77, 20. 2. 1982, M. Gogala leg., 29. 6. 1993, V. Furlan leg.
Kompolje, Četež pri Strugah, VL87, 28. 5. 1992, V. Furlan leg.
Cerkniško jezero, VL56, 1. 7. 1998, S. Gomboc leg.

Troilus luridus (Fabricius, 1775)
Gogala & Moder, 1960: Krvavec; Balarin, 1962: Hraše (Kranj); A. & M. Gogala, 1986, 1989
Specimens examined:
Ljubljana, 5. 1918, M. Hafner leg.
Kamniško-Savinjske Alpe: Krvavec, VM62, 23. 5. 1937, Staudacher leg.
Mozirje, Nazarje, VM93, 13. 9. 1987, D. Devetak leg.
Bloke: Volčje, Bloško jezero, VL67, 10. 9. 1988, A. & M. Gogala leg.
Cerkniško jezero: Cerknica, Otok, VL56, 13. 10. 2000, A. Gogala leg.
Ljubljana: Mostec, VM50, 1. 6. 2005, D. Fekonja leg.
Ljubljana, Golovec, VL69, 11. 5. 1980, 5. 4. 1981, 17. 4. 1982, V. Furlan leg.
Ig, VL69, 19. 4. 1980, V. Furlan leg.
Solčava, Pl. Grohat, VM84, 23. 7. 1977, V. Furlan leg.
Tržič, Kriška gora, VM43, 12. 6. 1976, V. Furlan leg.
Kamniška Bistrica, Dol. Korošice, VM62, 24. 4. 1982, V. Furlan leg.
Ratitovec, VM22, 22. 7. 1987, V. Furlan leg.

Zicrona caerulea (Linnaeus, 1758)
Gogala & Moder, 1960: Ljubljana, Lendava; A. & M. Gogala, 1986, 1989
Specimens examined:
Škofja Loka, Sorško polje, VM51, 2. 8. 1931, M. Hafner leg.
Laibach (= Ljubljana), 11. 9. 1937, Staudacher leg.
Prekmurje: Lendava, XM15, Staudacher leg.
Bevke, VL59, 6. 4. 1986, A. & M. Gogala leg.
Julijske Alpe: Studorski preval – Vodnikova koča, VM13, 13. 9. 1987, A. & M. Gogala leg.
Brestovica pri Komnu, UL97, 2. 5. 1990, A. & M. Gogala leg.
Črni Kal, VL14, 13. 6. 1992, A. & M. Gogala leg.
Brje pri Komnu, VL07, 16. 4. 2000, A. & M. Gogala leg., 12. 11. 2005, M. Gogala leg.
Kras: Lukovec, Poljska gora, VL07, 18. 6. 2005, A. Gogala leg.
Prekmurje: Muriša, XM24, 19. 6. 1996, S. Gomboc leg.
Ljubljana: Dobrunje – Sv. Urh, VL69, 25. 6. 1997, V. Furlan leg.
Brestovica pri Komnu, Klariči, UL97, 9. 6. 1995, B. Drovenik leg.
Krško, Mrtvice, WL48, 3. 9. 2003, A. Kapla leg.
Terme Čatež, WL48, 24. 4. 1998, V. Furlan leg.
Additional record:
Ljubljansko barje: Goričica, Goriški mah, VL59, 23. 6. 2006, photo A. Gogala

Pentatominae

Aelia acuminata (Linnaeus, 1758)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Črni Kal, Koper, Piran; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Črni Kal, VL14, 1. 7. 1979, A. & M. Gogala leg.
Koper, Bertoki, Škocjanski zatok, VL04, 18. 5. 1980, A. & M. Gogala leg., 7. 7. 2000, A. Gogala leg.
Prekmurje: Dobrovnik, Bukovniško jezero, XM07, 30. 4. 1983, A. & M. Gogala leg.
Portorož, Lucija, UL94, 2. 7. 1983, A. & M. Gogala leg.
Istra: Sočerga, VL13, 26. 7. 1984, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 18. 5. 1990, A. & M. Gogala leg.
Sečovlje, UL93, 7. 8. 1986, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 12. 6. 1989, M. Gogala leg.
Trstelj, UL98, 13. 8. 1989, A. & M. Gogala leg.
Nova Gorica, Kromberk, UL99, 2. 10. 1990, M. Gogala leg.
Hrpelje, Prešnica, VL14, 22. 6. 1991, V. Furlan leg.
Slavnik, VL14, 23. 6. 1991, V. Furlan leg.
Kozina, VL15, 22. 6. 1991, V. Furlan leg.
Maribor, Mariborski otok, WM45, 12. 5. 1992, V. Furlan leg.
Prekmurje: Bukovnica, XM07, 2. 6. 1999, S. Brelih leg.
Sočerga, Šeki, VL13, 14. 6. 1999, S. Brelih leg.
Nova Gorica, Panovec, UL98, 15. 5. 2000, S. Brelih leg.
Lipica, VL15, 30. 5. 1982, V. Furlan leg.
Bela krajina: Žuniči, WL23, 27. 4. 1983, V. Furlan leg.
Preloka, WL23, 27. 4. 1983, V. Furlan leg.
Bela krajina: Gradac, WL15, 28. 4. 1983, V. Furlan leg.
Podzemelj, WL25, 28. 4. 1983, V. Furlan leg.
Divača, VL26, 25. 5. 1985, V. Furlan leg.
Brežec pri Podgorju, VL14, 16. 5. 1990, V. Furlan leg.
Črni Kal, Socerb, VL14, 8. 5. 1990, V. Furlan leg.
Črni Kal, Praproče, VL14, 12. 7. 1990, V. Furlan leg.
Senožeče, Gabrče, VL26, 15. 6. 1987, V. Furlan leg.
Additional record:
Kostanjevica na Krki, Sajevce, Krakovski gozd, WL37, 24. 4. 2004, Z. Malinka leg.

Aelia rostrata Boheman, 1852
Aelia glebana Ferrari, 1874
Horváth, 1887a: Gorica; Gogala & Moder, 1960: Carniola; A. & M. Gogala, 1986, 1994
Specimens examined:
Črni Kal, VL14, 1. 7. 1979, A. & M. Gogala leg.

Istra: Sočerga, Veli Badin, VL13, 18. 5. 1990, 9. 6. 1990, 3. 10. 1990, A. & M. Gogala leg.
Brežec pri Podgorju, VL14, 16. 5. 1990, V. Furlan leg.

Neottiglossa bifida (A. Costa, 1847)
Specimen examined:
Istra: Koper, Škocjanski zatok, VL04, 30. 5. 2002, S. Brelih leg.
Additional record:
Sečovlje, Fontanigge, UL93, 20. 6. 2001, H. Günther leg.

Neottiglossa leporina (Herrich-Schaeffer, 1830)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Koper; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Črni Kal, VL14, 30. 6. 1979, A. & M. Gogala leg.
Istra: Koštabona, VL03, 25. 6. 1981, M. Gogala leg.
Sečovlje, UL93, 5. 8. 1981, 7. 8. 1986, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 12. 6. 1989, M. Gogala leg.
Brestovica pri Komnu, UL97, 2. 5. 1990, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 1. 8. 1990, A. & M. Gogala leg.
Slavnik, VL14, 19. 6. 1995, M. Gogala leg.
Movraž, Movraška vala, VL13, 5. 8. 1999, A. Gogala leg.
Koper, Bertoki, Škocjanski zatok, VL04, 22. 7. 2000, A. Gogala leg.
Sočerga, Šeki, VL13, 17. 6. 1999, S. Brelih leg.
Obrov, Golac, VL24, 3. 6. 2000, S. Brelih leg.
Dragonja, UL93, 4. 5. 2000, S. Brelih leg.
Istra: Zazid, 380 m, VL14, 26. 5. 2003, S. Brelih leg.
Brežec pri Podgorju, VL14, 16. 5. 1990, V. Furlan leg.

Neottiglossa lineolata (Mulsant & Rey, 1852)
Specimens examined:
Koper, Bertoki, Škocjanski zatok, VL04, 22. 7. 2000, A. Gogala leg., 23. 5. 2000, S. Brelih leg.
Dragonja, UL93, 4. 5. 2000, S. Brelih leg.
Sočerga, Šeki, VL13, 11. 5. 2000, S. Brelih leg.
Istra: Popetre, 300 m, VL13, 9. 7. 1997, S. Brelih leg.

Neottiglossa pusilla (Gmelin, 1790)
Neottiglossa inflexa (Wolff, 1811)
Montandon, 1886: Gorica; Protić, 1987: Podčetrtek; A. & M. Gogala, 1989
Specimens examined:
Idrija, Krekovše, VL19, 28. 6. 1988, M. Gogala leg.
Polhograjsko hrib.: Črni Vrh, Pasja ravan, VM40, 14. 8. 1996, A. Gogala leg.
Ig, Škrilje, Stražar, 720 m, VL68, 28. 5. 1999, A. Gogala leg.
Kum, 1000 m, WM00, 30. 5. 1989, V. Furlan leg.

Antheminia lunulata (Goeze, 1778)
Carpocoris lynx (Fabricius, 1794)
Montandon, 1886: Gorica; A. & M. Gogala, 1986, 1994; A. Gogala, 1992
Specimens examined:
Kraški rob: Črni Kal, VL14, 28. 6. 1980, 9. 7. 1980, A. & M. Gogala leg.
Kozina, VL15, 22. 6. 1991, V. Furlan leg.
Slavnik, 800 m, VL14, 24. 6. 1999, S. Brelih leg.
Additional record:
Vremščica, VL26, 11. 6. 2000, photo A. Gogala

Carpocoris fuscispinus (Boheman, 1851)
Carpocoris mediterraneus Tamanini, 1958
Gogala & Moder, 1960; Balarin, 1962: Radeče; A. & M. Gogala, 1986, 1989
Specimens examined:
Škofja Loka, Lubnik, VM41, 8. 1922, 29. 7. 1923, M. Hafner leg.
Škofja Loka, Sorško polje, VM51, 14. 8. 1932, 28. 7. 1935, M. Hafner leg.
Brkini: Barka, VL25, 28. 7. 1984, A. & M. Gogala leg.
Istra: Pomjan, VL03, 7. 9. 1985, A. & M. Gogala leg.
Kras: Lipica, VL15, 7. 7. 1987, M. Gogala leg.
Brje pri Komnu, VL07, 2. 7. 1989, 1. 4. 1990, A. & M. Gogala leg.
Trstelj, UL98, 13. 8. 1989, A. & M. Gogala leg.
Nanos: Sv. Hieronim, VL27, 25. 7. 1992, A. & M. Gogala leg.
Zazid, Lipnik, 800 m, VL13, 17. 6. 2000, A. Gogala leg.
Lukovec, Poljska gora, VL07, 6. 8. 2005, A. Gogala leg.
Lukovec, Golec, VL07, 25. 8. 2007, A. Gogala leg.
Istra: Zanigrad, VL14, 7. 7. 2003, S. Brelih leg.
Note: *C. mediterraneus* was recently synonymized with *C. fuscispinus* by Ribes *et al.* (2007). All examined specimens from Slovenia are of the more or less typical *fuscispinus* form. The typical *mediterraneus* form is probably not present in Slovenia. The record of *C. mediterraneus* by A. & M. Gogala (1986) is erroneus (it refers to *C. pudicus)* and doubtful by Balarin (1962).

Carpocoris melanocerus (Mulsant & Rey, 1852)
Gogala & Moder, 1960: Golica, Pohorje, Svinjak; Balarin, 1962: Podpeca; A. & M. Gogala, 1986, 1989
Specimens examined:
Krvavec, VM62, 5. 6. 1983, J. Carnelutti leg.
Sorica, Soriška planina, VM22, 23. 6. 1984, A. & M. Gogala leg.
Čaven, VL08, 11. 6. 1988, 22. 8. 1992, A. & M. Gogala leg.
Ilirska Bistrica, Štanga, VL44, 22. 7. 1992, 3. 6. 2000, A. & M. Gogala leg.
Julijske Alpe: Rombon – Pl. Goričica, UM83, 9.–11. 6. 2000, A. Kapla leg.
Jezersko, Ravenska Kočna, Žrelo, VM63, 29. 8. 2001, S. Gomboc & D. Kofol leg.

Porezen, VM21, 8. 7. 1976, V. Furlan leg.
Ratitovec – Prtovč, VM32, 10. 6. 1984, V. Furlan leg.
Kum, 1200 m, WM00, 20. 7. 1987, V. Furlan leg.

Carpocoris pudicus (Poda, 1761)
Gogala & Moder, 1960; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Medvode, Utik, VM61, 24. 8. 1928, Staudacher leg.
Črni Kal, VL14, 30. 6. 1979, 5. 8. 1981, A. & M. Gogala leg.
Domžale, Dob, VM71, 24. 7. 1982, A. & M. Gogala leg.
Štanjel, Kopriva, VL07, 2. 8. 1985, A. & M. Gogala leg.
Dragonja, Stena, UL93, 1. 10. 1987, A. & M. Gogala leg.
Brje pri Komnu, VL07, 21. 5. 1989, A. & M. Gogala leg., 23. 10. 2004 on *Eryngium*, A. Gogala leg.
Istra: Sočerga, VL13, 26. 7. 1984, A. & M. Gogala leg.
Nanos: Sv. Hieronim, VL27, 25. 7. 1992, A. & M. Gogala leg.
Kras: Lukovec, Poljska gora, VL07, 25. 8. 2007, A. Gogala leg.
Mozirje, Šmihel, VM93, 24. 8. 1996, V. Furlan leg.
Hrpelje, Prešnica, VL14, 6. 7. 1998, S. Brelih leg.
Hrastovlje, Podpeč, VL14, 23. 4. 1998, S. Gomboc leg.
Nova Gorica, Panovec, UL98, 6. 7. 2000, S. Brelih leg.
Polhograjsko hrib.: Grmada, VM40, 29. 7. 1979, V. Furlan leg.
Brežec pri Podgorju, VL14, 16. 5. 1990, V. Furlan leg.
Črni Kal, Črnotiče, VL14, 8. 5. 1990, V. Furlan leg.

Carpocoris purpureipennis (De Geer, 1773)
Carpocoris nigricornis (Fabricius, 1775)
Montandon, 1886: Gorica; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Laibach (= Ljubljana), 10. 5. 1927, 9. 9. 1928, Staudacher leg.
Julijske Alpe: Pl. Krstenica, VM13, 6. 1927, M. Hafner leg.
Bohinj: Pl. Vogar, VM12, 9. 7. 1936, M. Hafner leg.
Bohinj: Ukanc, VM02, 4. 6. 1978, A. & M. Gogala leg.
Vipavska dol.: Ozeljan, VL08, 7. 4. 1979, A. & M. Gogala leg.
Ig, Kureščček, VL68, 21. 6. 1980, A. & M. Gogala leg.
Istra: Koštabona, VL03, 25. 6. 1981, M. Gogala leg.
Medvode, Preska, VM50, 4. 7. 1981, A. & M. Gogala leg.
Bela krajina: Preloka, WL23, 13. 9. 1981, A. & M. Gogala leg.
Prekmurje: Petišovci, XM15, 30. 4. 1983, A. & M. Gogala leg.
Slavnik, VL14, 31. 5. 1981, 23. 6. 1991, A. & M. Gogala leg.
Polhograjsko hrib.: Črni Vrh, VM40, 15. 5. 1982, A. & M. Gogala leg.
Dobrovnik, XM06, 23. 7. 1983, A. & M. Gogala leg.
Bloke: Ulaka, VL57, 7. 8. 1983, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 10. 9. 1988, A. & M. Gogala leg.
Dragonja, Stena, UL93, 1. 10. 1987, A. & M. Gogala leg.
Šmarje pri Jelšah, WM42, 17. 8. 1988, A. & M. Gogala leg.
Bohinj, Voje, VM13, 25. 9. 1988, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 18. 5. 1990, A. & M. Gogala leg.
Ilirska Bistrica, Štanga, VL44, 22. 7. 1992, A. & M. Gogala leg.
Ljubljana, Lavrica, VL69, 20. 5. 1991, V. Furlan leg.
Hrpelje, Prešnica, VL14, 6. 7. 1998, S. Brelih leg.
Kozje, Podsreda, Loke, WL49, 9. 7. 1998, S. Brelih leg.
Nanos: Šembijska bajta, 800 m, VL27, 14. 7. 1999, S. Brelih leg.
Bovec – Kanin, UM83, 18. 7. 2000, S. Brelih leg.
Ribnica, Sodražica, VL76, 25. 6. 2005, D. Fekonja leg.
Ljubljana: Tomačevski prod, VM60, 6. 6. 2005, D. Fekonja leg.
Bela krajina: Podzemelj, WL25, 28. 4. 1983, V. Furlan leg.
Bela krajina: Žuniči, WL23, 27. 4. 1983, V. Furlan leg.
Suha krajina: Žvirče, VL87, 7. 5. 1983, V. Furlan leg.

Chlorochroa juniperina (Linnaeus, 1758)
Scopoli, 1763: Carniola; Gogala & Moder, 1960: Bohinj; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Črni Kal, VL14, 10. 1976, M. Gogala leg., 26. 10. 1985, A. & M. Gogala leg.
Kamnik pod Krimom, Ponikve, VL58, 4. 10. 1981, A. & M. Gogala leg.
Hrpelje, VL15, 2. 7. 1982, A. & M. Gogala leg.
Pokojišče, VL48, 12. 9. 1982, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 7. 8. 1983, 10. 9. 1988, A. & M. Gogala leg.
Štorje, VL16, 26. 3. 1989, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 4. 2. 1990, A. & M. Gogala leg.
Kras: Gorjansko, UL97, 22. 2. 1992, M. Gogala leg., 1. 5. 2000, A. & M. Gogala leg.
Hrpelje, Prešnica, VL14, 23. 5. 1999, S. Brelih leg.
Sočerga, Šeki, VL13, 14. 6. 1999, S. Brelih leg.

Chlorochroa pinicola (Mulsant & Rey, 1852)
Gogala & Moder, 1960: Rašica, Šentvid nad Lj.; A. & M. Gogala, 1986, 1989
Specimens examined:
Bohinj: Stara Fužina, VM12, 22. 5. 1977, A. & M. Gogala leg.
Planinsko polje: Planina, VL47, 19. 4. 1981, A. & M. Gogala leg.
Senožeče, VL26, 5. 5. 1984, A. & M. Gogala leg.

Sp. Brnik, VM61, 2. 9. 1988, M. Gogala leg., 7. 9. 1988, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 10. 9. 1988, A. & M. Gogala leg.
Brje pri Komnu, VL07, 25. 2. 1990, A. & M. Gogala leg.
Kras: Gorjansko, UL97, 27. 4. 1992, A. & M. Gogala leg.
Cerkniško jezero: Gorica, VL56, 15. 10. 1998, A. Gogala leg.
Additional record:
Log, Lukovica, VL59, 8. 6. 2004, photo A. Gogala

Dolycoris baccarum (Linnaeus, 1758)
Carpocoris verbasci (De Geer, 1773)
Scopoli, 1763: Carniola; Montandon, 1886: Gorica; Kormilev, 1929: Ptuj; Gogala & Moder, 1960; Balarin, 1962: Radeče; A. & M. Gogala, 1986, 1989, 1994; Protić, 1987: Podčetrtek
Specimens examined:
Ljubljansko barje: Plešivica, VL59, 23. 4. 1978, A. & M. Gogala leg.
Bohinj: Ukanc, VM02, 3. 7. 1978, A. & M. Gogala leg.
Senožeče, VL26, 15. 4. 1979, A. & M. Gogala leg.
Ig, Kureščček, VL68, 21. 6. 1980, A. & M. Gogala leg.
Grosuplje, Velike Lipljene, VL78, 30. 8. 1981, A. & M. Gogala leg.
Kamnik pod Krimom, Ponikve, VL58, 20. 6. 1982, A. & M. Gogala leg.
Soška dolina: izliv Lepenjice, UM93, 18. 7. 1982, A. & M. Gogala leg.
Domžale, Dob, VM71, 24. 7. 1982, A. & M. Gogala leg.
Petišovci, XM15, 30. 4. 1983, A. & M. Gogala leg.
Kras: Štorje, VL16, 8. 6. 1983, A. & M. Gogala leg.
Cerknica, Dolenje Jezero, VL56, 29. 6. 1983, A. & M. Gogala leg.
Jezersko, VM64, 14. 8. 1983, A. & M. Gogala leg.
Sorica, Soriška planina, VM22, 23. 6. 1984, A. & M. Gogala leg.
Strunjan, UL94, 16. 10. 1985, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 19. 4. 1987, A. & M. Gogala leg.
Prekmurje: Korovci, WM77, 14. 6. 1987, A. & M. Gogala leg.
Čaven, VL08, 11. 6. 1988, A. & M. Gogala leg.
Podolševa, Žibovt – Kisla voda, VM74, 26. 6. 1988, A. & M. Gogala leg.
Šmarje pri Jelšah, WM42, 17. 8. 1988, A. & M. Gogala leg.
Zg. Radovna, VM14, 28. 8. 1988, A. & M. Gogala leg.
Koštabona, Supotski slap, VL03, 12. 10. 1988, A. & M. Gogala leg.
Brje pri Komnu, VL07, 5. 5. 1989, A. & M. Gogala leg.
Črnotiče, VL14, 8. 7. 1990, A. & M. Gogala leg.
Trstelj, UL98, 19. 8. 1990, A. & M. Gogala leg.
Istra: Popetre, VL13, 9. 7. 1997, S. Brelih leg.
Sevnica, Šentvid pri Planini, WM30, 11. 5. 1993, V. Furlan leg.
Hrpelje, Prešnica, VL14, 6. 7. 1998, S. Brelih leg.
Nanos, 850 m, VL27, 31. 3. 1998, S. Gomboc leg.
Nanos: Šembijska bajta, 800 m, VL27, 14. 7. 1999, S. Brelih leg.
Nova Gorica, Panovec, UL98, 15. 5. 2000, S. Brelih leg.
Osp, VL14, 20. 8. 1998, S. Gomboc & D. Kofol leg.
Lenart, Cerkvenjak, WM75, 31. 7. 2005, D. Fekonja leg.
Krško, Leskovec, WL38, 18. 6. 2005, D. Fekonja leg.
Ljubljana: Prule, VM60, 20. 5. 2005, D. Fekonja leg.
Murska Sobota, Bogojina, WM97, 13. 8. 2005, D. Fekonja leg.
Slavnik, VL14, 27. 4. 1977, V. Furlan leg.
Trnovski gozd: Lokve, Nemci, VL09, 10. 6. 1978, V. Furlan leg.
Lipica, VL15, 30. 5. 1982, 25. 5. 1985, V. Furlan leg.
Ig, Mokrec, 900 m, VL68, 9. 8. 1982, V. Furlan leg.
Kranj, Besnica, VM42, 30. 5. 1982, J. Broder leg.
Ljubljana, Golovec: Orle, VL69, 23. 4. 1983, V. Furlan leg.
Bela krajina: Žuniči, WL23, 27. 4. 1983, V. Furlan leg.
Preloka, WL23, 27. 4. 1983, V. Furlan leg.
Podzemelj, WL25, 28. 4. 1983, V. Furlan leg.
Vinica, WL13, 29. 4. 1983, V. Furlan leg.
Suha krajina: Žvirče, VL87, 7. 5. 1983, V. Furlan leg.
Muljava, VL88, 7. 5. 1983, V. Furlan leg.
Radovna, VM24, 14. 5. 1983, V. Furlan leg.
Unec, VL47, 25. 5. 1985, V. Furlan leg.
Komna, 1525 m, VM02, 4. – 7. 7. 1984, V. Furlan leg.
Topol, Osredek, VM50, 3. 6. 1984, V. Furlan leg.
Kamniška Bistrica, Konec, 1100 m, VM63, 18. 8. 1984, V. Furlan leg.
Škofja Loka, Križna Gora, VM41, 30. 5. 1983, V. Furlan leg.
Sočerga, Mlini, Veli Badin, VL13, 16. 5. 1990, V. Furlan leg.
Kum, 1000 m, WM00, 30. 5. 1989, V. Furlan leg.
Polhograjsko hrib.: Grmada, VM40, 9. 5. 1987, V. Furlan leg.
Gornji Ig, VL68, 23. 5. 1987, V. Furlan leg.
Gorjanci: Sv. Miklavž, WL26, 29. 8. 1990, V. Furlan leg.
Loški potok, VL66, 8. 6. 1997, V. Furlan leg.

Holcostethus albipes (Fabricius, 1781)
A. & M. Gogala, 1986
Specimen examined:
Istra: Piran, UL84, 30. 9. 1979, A. & M. Gogala leg.

Holcostethus sphacelatus (Fabricius, 1794)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Vižmarje; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Ljubljana: Vižmarje, VM50, 25. 10. 1929, Staudacher leg.

Bohinj: Ribčev laz, VM12, 7. 1930, M. Hafner leg.
Žirovnica, Završnica, VM34, 22. 5. 1921, M. Hafner leg.
Julijske Alpe: Črna prst, VM12, 10. 6. 1923, M. Hafner leg.
Turjak, VL78, 25. 5. 1980, A. & M. Gogala leg.
Log, Lukovica, VL59, 29. 6. 1983, M. Gogala leg.
Polhograjsko hrib.: Črni Vrh, VM40, 9. 8. 1984, A. & M. Gogala leg.
Portorož, Beli Križ, UL84, 10. 10. 1984, M. Gogala leg.
Istra: Portorož, UL94, 15. 10. 1986, A. & M. Gogala leg.
Trstelj, UL98, 19. 8. 1990, A. & M. Gogala leg.
Kraški rob: Prešnica, VL14, 22. 6. 1991, A. & M. Gogala leg.
Ilirska Bistrica, Štanga, VL44, 22. 7. 1992, A. & M. Gogala leg.
Predmeja, VL18, 1. 7. 1993, M. Gogala leg.
Sp. Branica, Čipnje, VL07, 25. 5. 1997, A. & M. Gogala leg.
Ljubljana: Žale, VM60, 17. 4. 2000, A. & M. Gogala leg.
Kras: Veliki Dol, VL07, 5. 5. 2001, A. & M. Gogala leg.
Novo mesto, Trška gora, WL17, 16. 6. 1991, V. Furlan leg.
Hrpelje, Prešnica, VL14, 10. 5. 1999, S. Brelih leg.
Bovec – Kanin, UM83, 18. 7. 2000, S. Brelih leg.
Polhograjsko hrib.: Grmada, 700 m, VM40, 10. 7. 1985, V. Furlan leg.
Sočerga, Mlini, Veli Badin, VL13, 12. 6. 1990, V. Furlan leg.

Palomena prasina (Linnaeus, 1761)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Ljubljana, Bohinj, Birčna vas, Brežice, Trenta; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Laibach (= Ljubljana), 14. 7. 1929, 15. 9. 1929, 25. 11. 1929, Staudacher leg.
Pokojišče, VL58, 26. 6. 1932, Staudacher leg.
Radovljica, Lancovo, VM33, 4. 8. 1929, Staudacher leg.
Ljubljana: Rožnik, VM50, 25. 1. 1954, M. Gogala leg.
Bohinj: Ukanc, VM02, 4. 9. 1977, A. & M. Gogala leg.
Bled, VM33, 24. 4. 1979, A. & M. Gogala leg.
Ig, Draga, VL68, 15. 8. 1976, S. Brelih leg.
Ig, Kremenica, VL68, 29. 8. 1976, S. Brelih leg.
Idrija, VL29, 13. 4. 1980, A. & M. Gogala leg.
Bela krajina: Črnomelj, Rožanec, WL15, 13. 9. 1981, A. & M. Gogala leg.
Ljubljansko barje: Bevke, VL59, 27. 3. 1982, A. & M. Gogala leg.
Prekmurje: Dobrovnik, Bukovniško jezero, XM07, 30. 4. 1983, A. & M. Gogala leg.
Log, Lukovica, VL59, 30. 5. 1983, A. & M. Gogala leg.
Istra: Dragonja, Stena, UL93, 1. 10. 1987, A. & M. Gogala leg.
Postojna, Zagon, VL37, 21. 9. 1983, A. & M. Gogala leg.
Slavnik, VL14, 2. 6. 1984, A. & M. Gogala leg.
Brkini: Artviže, VL25, 28. 7. 1984, A. & M. Gogala leg.
Vuhred, Hudi kot, WM15, 2. 6. 1986, M. Gogala leg.
Goričko: Trdkova, WM89, 14. 6. 1987, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 11. 7. 1987, A. & M. Gogala leg.
Ajdovščina, Planina, VL17, 25. 3. 1988, A. & M. Gogala leg.
Zg. Radovna, VM14, 28. 8. 1988, A. & M. Gogala leg.
Sp. Brnik, VM61, 2. 9. 1988, M. Gogala leg.
Brje pri Komnu, VL07, 28. 5. 1989, A. & M. Gogala leg.
Kras: Lipica, VL15, 16. 5. 1992, A. & M. Gogala leg.
Cerkniško jezero: Dolenje Jezero, VL56, 25. 4. 1992, A. & M. Gogala leg.
Nova Gorica, Sv. Katarina, UL99, 28. 7. 1995, S. Gomboc leg.
Ljubljana, VL69, 30. 10. 1996, V. Furlan leg.
Bovec – Kanin, UM83, 8. 8. 2000, S. Brelih leg.
Nova Gorica, Panovec, UL98, 15. 5. 2000, S. Brelih leg.
Bistrica ob Sotli, WM50, 18. 5. 2000, S. Brelih leg.
Prekmurje: Gančani, WM96, 19. 9. 1992, S. Gomboc leg.
Lenart, Cerkvenjak, WM75, 12. 8. 2005, D. Fekonja leg.
Krško, WL39, 21. 8. 2005, D. Fekonja leg.
Porezen, VM21, 8. 7. 1976, V. Furlan leg.
Črni Kal, Socerb, VL14, 12. 6. 1990, V. Furlan leg.
Bela krajina: Semič, Gornja Paka, WL15, 29. 4. 1983, V. Furlan leg.
Novo mesto, Trška gora, WL17, 21. – 22. 5. 1983, V. Furlan leg.
Sočerga, Mlini, Veli Badin, VL13, 24. 7. 1990, V. Furlan leg.
Muljava, VL88, 7. 5. 1983, V. Furlan leg.
Loški potok, VL66, 30. 9. 1995, V. Furlan leg.
Ljubljana, Golovec: Orle, VL69, 13. 3. 1991, V. Furlan leg.

Palomena viridissima (Poda, 1761)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Ljubljana, Hotedrščica, Golica, Toško čelo; A. & M. Gogala, 1986; Protić, 1987: Podčetrtek, 2001: Gorica
Specimens examined:
Laibach (= Ljubljana), 30. 9. 1928, 15. 9. 1929, 25. 11. 1929, 8. 9. 1937, Staudacher leg.
Ljubljansko barje: Plešivica, VL59, 23. 4. 1978, A. & M. Gogala leg.
Škofja Loka, VM41, 13. 5. 1979, A. & M. Gogala leg.
Ig, Kremenica, VL68, 28. 9. 1975, S. Brelih leg.
Ljubljana: Šiška, VM50, 8. 2. 1980, A. & M. Gogala leg.
Bela krajina: Podzemelj, WL25, 28. 4. 1983, V. Furlan leg.
Črnomelj, Veliki Nerajec, WL14, 29. 4. 1983, V. Furlan leg.
Ljubljana, Golovec: Orle, VL69, 20. 5. 1984, V. Furlan leg.
Ljubljana, Lavrica, VL69, 8. 6. 1991, V. Furlan leg.
Kresnice, VM80, 30. 5. 1991, V. Furlan leg.

Peribalus strictus (Fabricius, 1803)
Holcostethus vernalis (Wolff, 1804)
Peribalus distinctus (Fieber, 1861)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Ljubljana, Črnuče, Kamn. Bistrica, Koper; A. & M. Gogala, 1986, 1989; Protić, 1987: Podčetrtek
Specimens examined:
Ljubljana, 9. 1976, A. & M. Gogala leg.
Ljubljansko barje: Plešivica, VL59, 23. 4. 1978, A. & M. Gogala leg.
Log, Lukovica, VL59, 11. 7. 1981, A. & M. Gogala leg.
Ljubljana: Šiška, VM50, 19. 8. 1981, A. Gogala leg.
Bela krajina: Vinica, Zilje, WL23, 13. 9. 1981, A. & M. Gogala leg.
Ig, Draga, VL68, 15. 8. 1976, S. Brelih leg.
Senožeče, VL26, 28. 6. 1982, M. Gogala leg.
Postojna, Zagon, VL37, 21. 9. 1983, A. & M. Gogala leg.
Slavnik, VL14, 2. 6. 1984, A. & M. Gogala leg.
Brkini: Artviže, VL25, 28. 7. 1984, A. & M. Gogala leg.
Polhograjsko hrib.: Črni Vrh, Pasja ravan, VM40, 4. 6. 1985, A. & M. Gogala leg.
Cerkniško jezero: Dolenje Jezero, VL56, 24. 5. 1987, A. & M. Gogala leg.
Cerkniško jezero: Gorenje Jezero, VL56, 23. 8. 2002, A. Gogala leg.
Idrija, Krekovše, VL19, 28. 6. 1988, M. Gogala leg.
Podolševa, Žibovt – Kisla voda, VM74, 26. 6. 1988, A. & M. Gogala leg.
Šmarje pri Jelšah, WM42, 17. 8. 1988, A. & M. Gogala leg.
Sp. Brnik, VM61, 2. 9. 1988, M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 10. 9. 1988, A. & M. Gogala leg.
Kranjska Gora, Podkoren, VM05, 19. 9. 1988, M. Gogala leg.
Bohinj, Voje, VM13, 25. 9. 1988, A. & M. Gogala leg.
Nanos: Sv. Hieronim, VL27, 25. 7. 1992, A. & M. Gogala leg.
Portorož, UL84, 8. 1973, A. & M. Gogala leg.
Portorož, Beli Križ, UL84, 10. 10. 1984, M. Gogala leg., 16. 10. 1985, A. & M. Gogala leg.
Piran, UL84, 30. 9. 1979, A. & M. Gogala leg., 3. 10. 1986, M. Gogala leg.
Istra: Koštabona, Supotski slap, VL03, 12. 10. 1988, A. & M. Gogala leg.
Kraški rob: Bezovica, VL14, 14. 6. 1991, A. & M. Gogala leg.
Osp, VL14, 13. 6. 1992, A. & M. Gogala leg.
Topol, Sv. Katarina, VM50, 9. 6. 1991, 7. 7. 1991, V. Furlan leg.
Ljubljana, Golovec: Orle, VL69, 13. 5. 1991, V. Furlan leg.
Haloze: Cirkulane, Brezovec, WM73, 8. 8. 1998, S. Brelih leg.
Hrpelje, Prešnica, VL14, 23. 5. 1999, 7. 6. 1999, S. Brelih leg.
Obrov, Golac, VL24, 10. 6. 1999, S. Brelih leg.
Nanos: Šembijska bajta, 800 m, VL27, 14. 7. 1999, S. Brelih leg.
Krško, Leskovec, WL38, 18. 6. 2005, D. Fekonja leg.
Muljava, VL88, 24. 8. 1982, V. Furlan leg.
Bela krajina: Podzemelj, WL25, 28. 4. 1983, V. Furlan leg.
Črnomelj, Veliki Nerajec, WL14, 29. 4. 1983, V. Furlan leg.
Suha krajina: Žvirče, VL87, 7. 5. 1983, V. Furlan leg.
Lipica, VL15, 25. 5. 1985, V. Furlan leg.
Ratitovec, Prtovč, VM32, 10. 6. 1984, V. Furlan leg.
Krim, 950 m, VL58, 23. 5. 1987, V. Furlan leg.
Gorjanci: Jugorje, WL16, 27. 4. 1983, V. Furlan leg.
Kum, 1000 m, WM00, 30. 5. 1989, V. Furlan leg.
Kozina, VL15, 22. 6. 1991, V. Furlan leg.
Zaplana, Cesarski vrh, VL49, 27. 5. 1991, V. Furlan leg.
Postojna, VL37, 10. 6. 1991, V. Furlan leg.
Šmarješke toplice, WL28, 11. 6. 1992, V. Furlan leg.
Kozjansko: Šentvid pri Planini, WM30, 11. 5. 1993, V. Furlan leg.
Kočevska Reka, Borovška dolina, VL84, 15. 6. 1993, V. Furlan leg.
Loški potok, VL66, 17. 5. 1997, V. Furlan leg.
Note: Generally, the nominate subspecies *P. s. strictus* populates Istra southwest of the Karst edge, while the rest of the territory of Slovenia is populated by the subspecies *P. s. vernalis* (Wolff). The genus *Peribalus* has been separated from *Holcostethus* by Belousova (2007).

Rubiconia intermedia (Wolff, 1811)
Montandon, 1886: Gorica; A. & M. Gogala, 1986, 1989; Protić, 1987: Podčetrtek, 2001: Gorica
Specimens examined:
Bela krajina: Vinica, Zilje, WL23, 13. 9. 1981, A. & M. Gogala leg.
Šmarje pri Jelšah, WM42, 17. 8. 1988, A. & M. Gogala leg.
Podčetrtek, Vonarje, WM41, 6. 8. 1996, A. Gogala leg.
Ljubljana, Črnuče, Jarški prod, VM60, 23. 6. 2004, A. Gogala leg.
Kranj, Brdo, VM52, 31. 8. 2006 on *Calluna*, A. Gogala leg.
Kozje, Podsreda, Loke, WL49, 9. 7. 1998, S. Brelih leg.
Ptuj, Šturmovci, WM73, 3. 7. 1998, S. Gomboc leg.
Muljava, VL88, 20. 5. 1981, V. Furlan leg.
Novo mesto, Trška gora, WL17, 6. 6. 1987, V. Furlan leg.
Podkum, Sopota, WM00, 24. 5. 1990, V. Furlan leg.
Prekmurje: Andrejci, WM97, 23. 5. 1989, V. Furlan leg.
Bela krajina: Preloka, WL23, 1. 8. 1990, V. Furlan leg.
Stara Lipa, Drežnik, WL13, 30. 6. 1993, V. Furlan leg.
Šmarješke toplice, WL17, 11. 6. 1992, V. Furlan leg.
Additional record:
Julijske Alpe: Dovje env., 660 – 2000 m, VM14, 29. 6. – 2. 7. 2005, J. Kolibáč leg.

Staria lunata (Hahn, 1835)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Črni Kal; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Koštabona, VL03, 25. 6. 1981, M. Gogala leg.
Črni Kal, VL14, 30. 6. 1979, 28. 6. 1980, A. & M. Gogala leg.
Ig, Kremenica, VL68, 11. 7. 1976, S. Brelih leg.
Kozina, VL15, 5. 8. 1981, A. & M. Gogala leg.
Padna, UL93, 16. 6. 1984, A. & M. Gogala leg.
Barka, VL25, 28. 7. 1984, A. & M. Gogala leg.
Štanjel, Kopriva, VL07, 2. 8. 1985, A. & M. Gogala leg.
Portorož, UL94, 15. 10. 1986, A. & M. Gogala leg.
Istra: Labor, VL03, 9. 9. 1987, A. Gogala leg.
Šmarje pri Jelšah, WM42, 17. 8. 1988, A. & M. Gogala leg.
Brje pri Komnu, VL07, 12. 6. 1989, M. Gogala leg.
Kras: Trstelj, UL98, 13. 8. 1989, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 9. 6. 1990, A. & M. Gogala leg.
Istra: Hrvoji, VL03, 21. 7. 1997, S. Brelih leg.
Opatje selo, UL97, 27. 6. 1998, S. Gomboc leg.
Hrpelje, Prešnica, VL14, 7. 6. 1999, S. Brelih leg.
Hrpelje, VL15, 24. 6. 1999, S. Brelih leg.
Sočerga, Šeki, VL13, 14. 6. 1999, S. Brelih leg.
Lipica, VL15, 30. 5. 1982, V. Furlan leg.
Novo mesto, Trška gora, WL17, 6. 6. 1987, 16. 6. 1991, V. Furlan leg.
Črni Kal, Praproče, VL14, 12. 7. 1990, V. Furlan leg.
Additional records:
Movraž, Kuk, VL13, 14. 7. 2007, photo A. Gogala
Savinjske Alpe: Logarska dolina, 700 – 1100 m, VM74, 21. – 24. 6. 2005, J. Kolibáč leg.

Eysarcoris aeneus (Scopoli, 1763)
Eysarcoris perlatus (Fabricius, 1794)
Scopoli, 1763: Idrija – type locality; Montandon, 1886: Gorica; Gräffe, 1911: Tolmin; Kormilev, 1929: Gorica; Gogala & Moder, 1960: Ljubljana, Dobrova, Utik, Črnuče, Bohinj; A. & M. Gogala, 1986; Protić, 1987: Podčetrtek
Specimens examined:
Medvode, Utik, VM61, 19. 2. 1928, Staudacher leg.
Laibach (= Ljubljana), 20. 8. 1931, 1. 6. 1937, Staudacher leg.
Ljubljana: Vič, VL59, 19. 4. 1936, Staudacher leg.
Ljubljana, Črnuče, VM60, 25. 6. 1933, Staudacher leg., 21. 6. 1982, A. & M. Gogala leg.
Ljubljana: Večna pot, VM50, 1. 10. 1954, M. Gogala leg.
Log, Lukovica, VL59, 16. 8. 1983, A. & M. Gogala leg.
Bohinj: Ukanc, VM02, 4. 6. 1978, A. & M. Gogala leg.
Ljubljansko barje: Bevke, VL59, 25. 5. 1977, 14. 6. 1980, A. & M. Gogala leg.
Vrhnika, Log, VL59, 7. 3. 1981, A. & M. Gogala leg.
Istra: Sečovlje, UL93, 5. 8. 1981, A. & M. Gogala leg.
Ig, VL69, 10. 7. 1982, A. & M. Gogala leg.
Prekmurje: Dobrovnik, XM06, 23. 7. 1983, A. & M. Gogala leg.
Osilnica, Plešce, slov. stran reke, VL74, 27. 7. 1985, A. & M. Gogala leg.
Kočevje, Dolga vas, VL95, 4. 7. 1997, S. Brelih leg.
Dolina pri Lendavi, XM15, 11. 7. 1998, S. Gomboc leg.
Podsreda, Trebča Gorca, WM40, 18. 5. 2000, S. Brelih leg.
Nova Gorica, Panovec, UL98, 15. 5. 2000, S. Brelih leg.
Bela krajina: Preloka, WL23, 27. 4. 1983, V. Furlan leg.
Žuniči, WL23, 27. 4. 1983, V. Furlan leg.
Ljubljana, Golovec: Orle, VL69, 20. 5. 1984, V. Furlan leg.
Ljubljana: Dobrunje, VL69, 11. 5. 1992, V. Furlan leg.
Kozjansko: Sedlarjevo, WM40, 23. 6. 1993, V. Furlan leg.
Kočevska Reka, Borovška dolina, VL84, 15. 6. 1993, V. Furlan leg.
Rače, Veliki ribnik, WM54, 12. 5. 1992, V. Furlan leg.
Note: Rider (2006) listed Italy or Slovenia as countries of origin of this species' type material, although Scopoli clearly stated that he collected it around Idrija ("Circa *Idriam* in herbidis collibus").

Eysarcoris ventralis (Westwood, 1837)
Eysarcoris inconspicuus (Herrich-Schaeffer, 1844)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Dol pri Lj., Češnjica; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Črni Kal, VL14, 15. 4. 1979, A. & M. Gogala leg.
Piran, UL84, 30. 9. 1979, A. & M. Gogala leg.
Koštabona, VL03, 25. 6. 1981, M. Gogala leg.
Padna, UL93, 4. 11. 1983, A. & M. Gogala leg.
Istra: Kubed, VL14, 16. 4. 1988, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 10. 10. 1999, A. & M. Gogala leg.
Koper, Bertoki, Škocjanski zatok, VL04, 7. 7. 2000, A. Gogala leg.
Nova Gorica, Panovec, UL98, 15. 5. 2000, S. Brelih leg.
Dragonja, UL93, 4. 5. 2000, S. Brelih leg.

Eysarcoris venustissimus (Schrank, 1776)
Eysarcoris fabricii Kirkaldy, 1904
Gogala & Moder, 1960: Ljubljana, Jetrbenk, Polhov Gradec, Friedrichstein, Bohinj; A. & M. Gogala, 1986, 1989, 1994; Protić, 1987: Podčetrtek
Specimens examined:
Billichgraz (= Polhov Gradec), VM40, 9. 9. 1934, Staudacher leg.
Friedrichstein (= Kočevje, Fridrihštajn), VL85, 7. 6. 1937, Staudacher leg.
Topol, Jeterbenk, VM50, 29. 6. 1933, Staudacher leg.
Ig, Draga, VL68, 29. 6. 1976, S. Brelih leg.
Ljubljansko barje: Log, Lukovica, VL59, 11. 7. 1981, A. & M. Gogala leg.

Kamnik pod Krimom, Ponikve, VL58, 20. 6. 1982, A. & M. Gogala leg.
Idrija, Krekovše, VL19, 28. 6. 1988, M. Gogala leg.
Pokojišče, VL58, 3. 6. 1988, S. Brelih leg.
Kraški rob: Osp, VL14, 8. 7. 1990, A. & M. Gogala leg.
Komen, Branik, VL07, 27. 5. 1998, S. Brelih leg.
Haloze: Cirkulane, Brezovec, WM73, 8. 8. 1998, S. Brelih leg.
Nanos, VL27, 2. 6. 1974, V. Furlan leg.
Bela krajina: Preloka, WL23, 27. 4. 1983, V. Furlan leg.
Kranj, Besnica, VM42, 30. 5. 1982, J. Broder leg.
Kamnik, VM62, 15. 5. 1983, B. Drovenik leg.
Škofja Loka, Križna Gora, VM41, 30. 5. 1983, B. Kofler leg.
Unec, VL47, 25. 5. 1985, V. Furlan leg.
Podkum, WM00, 24. 5. 1989, V. Furlan leg.
Selška dolina: Praprotno, VM41, 29. 5. 1987, V. Furlan leg.
Ljubljana: Ježica, VM60, 12. 6. 1991, V. Furlan leg.
Ljubljana, Golovec: Orle, VL69, 6. 9. 1991, V. Furlan leg.
Novo mesto, Trška gora, WL17, 16. 6. 1991, V. Furlan leg.
Postojna, VL37, 10. 6. 1991, V. Furlan leg.
Topol, Sv. Katarina, VM50, 9. 6. 1991, V. Furlan leg.
Mrzlica: preval Vrhe, WM01, 28. 5. 1991, V. Furlan leg.
Kočevska Reka, Borovška dolina, VL84, 15. 6. 1993, V. Furlan leg.

Stagonomus amoenus (Brullé, 1832)
Gogala, 1996; Derjanschi & Péricart, 2005: Gorica
Specimens examined:
Kras: Brje pri Komnu, VL07, 28. 5. 1995, 1. 6. 1996 on *Salvia officinalis*, A. Gogala leg.
Hrpelje, Prešnica, VL14, 10. 5. 1999, S. Brelih leg.
Additional record:
Štanjel, Lukovec, VL07, 21. 4. 2007 on *Salvia pratensis*, photo A. Gogala

Stagonomus bipunctatus (Linnaeus, 1758)
Stagonomus pusillus (Herrich-Schaeffer, 1833)
Horváth, 1887a: Gorica; Gogala & Moder, 1960: Ljubljana, Kamn. Bistrica, Dobrova; Protić, 1987: Podčetrtek; Gogala, 1991; A. & M. Gogala, 1994
Specimens examined:
Istra: Sočerga, Veli Badin, VL13, 9. 6. 1990 on *Teucrium flavum*, A. & M. Gogala leg.
Osp, VL14, 8. 7. 1990, A. & M. Gogala leg.
Strunjan, UL94, 12. 5. 1998, A. & M. Gogala leg.
Kozina, VL15, 22. 6. 1991, V. Furlan leg.
Pivka, Jurišče, VL45, 9. 9. 2007 on *Verbascum*, A. Gogala leg.

Acrosternum heegeri Fieber, 1861
Specimen examined:
Istra: Dragonja, Pišine, UL93, 1. 2. 1997, A. & M. Gogala leg.

Acrosternum millierei (Mulsant & Rey, 1866)
Montandon, 1886: Gorica

Nezara viridula (Linnaeus, 1758)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Bohinjska Češnjica, Fjesa; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Istra: Portorož, UL84, 8. 1973, M. Gogala leg.
Strunjan, UL94, 22. 9. 1982, 16. 10. 1985, A. & M. Gogala leg.
Portorož, Beli Križ, UL84, 10. 10. 1984, M. Gogala leg.
Ankaran, VL04, 17. 2. 1988, A. & M. Gogala leg.
Osp, VL14, 8. 7. 1990, A. & M. Gogala leg.
Kraški rob: Bezovica, VL14, 3. 10. 1990, 28. 2. 1992, A. & M. Gogala leg.
Nova Gorica, Kromberk, UL99, 2. 10. 1990, M. Gogala leg.
Sečovlje, Fontanigge, UL93, 12. 9. 1992, A. & M. Gogala leg.
Kras: Gorjansko, Nadrožica, VL07, 21. 10. 2001, A. & M. Gogala leg.
Sočerga, Mlini, Veli Badin, VL13, 16. 5. 1990, V. Furlan leg.
Strunjan, rt Ronek, UL94, 3. 9. 1998, V. Furlan leg.

Pentatoma rufipes (Linnaeus, 1758)
Montandon, 1886: Gorica; Kormilev, 1929: Ptuj; Gogala & Moder, 1960: Ljubljana, Domžale, Šmartno ob Savi, Bohinj, Dobrova, Trojane; Balarin, 1962: Tržič; A. & M. Gogala, 1986, 1989; Floren & Gogala, 2002: Kočevje, Rajhenavski Rog (WL06)
Specimens examined:
Laibach (= Ljubljana), 20. 7. 1929, 30. 9. 1930, Staudacher leg.
Ljubljana, VM50, 26. 9. 1977, A. & M. Gogala leg.
Ljubljansko barje: Ig, Kremenica, VL68, 21. 9. 1975, S. Brelih leg.
Medvode, Jeprca, VM51, 22. 8. 1981, A. & M. Gogala leg.
Bela krajina: Preloka, WL23, 13. 9. 1981, A. & M. Gogala leg.
Log, Lukovica, VL59, 12. 9. 1982, A. & M. Gogala leg.
Bohinj: Ukanc, VM02, 5. 7. 1983, A. & M. Gogala leg.
Rovte, VL39, 22. 7. 1983, A. & M. Gogala leg.
Polhograjsko hrib.: Črni Vrh, VM40, 10. 8. 1983, A. & M. Gogala leg.
Postojna, Landol, VL37, 21. 9. 1983, A. & M. Gogala leg.
Osilnica, Plešce, slov. stran reke, VL74, 27. 7. 1985, A. & M. Gogala leg.
Šmarje pri Jelšah, WM42, 17. 8. 1988, A. & M. Gogala leg.

Celje, WM22, 19. 9. 1968, I. Sivec leg.
Podčetrtek, Vonarje, WM41, 6. 8. 1996, A. Gogala leg.
Vrhnika, VL49, 30. 9. 1998, T. Trilar leg.
Kranj, Brdo, VM52, 14. 7. 2006 on *Alnus*, A. Gogala leg.
Novo mesto, Trška gora, WL17, 21. 7. 1995, 9. 10. 1999, V. Furlan leg.
Dobrovnik, XM06, 15. 8. 1998, S. Gomboc leg.
Prekmurje: Muriša, XM24, 16. 7. 1998, S. Gomboc leg.
Bovec – Kanin, UM83, 18. 7. 2000, S. Brelih leg.
Nova Gorica, Panovec, UL98, 13. 9. 2000, S. Brelih leg.
Ribnica, Sodražica, VL76, 24. 9. 2005, D. Fekonja leg.
Breginj, Podbela, UM82, 7. 1982, B. Drovenik leg.
Solčava, Pl. Grohat, VM84, 23. 7. 1977, V. Furlan leg.
Ig, Iška vas, VL68, 9. 9. 1987, V. Furlan leg.
Zasavje: Tepe, Pasjek, VM90, 3. 9. 1991, V. Furlan leg.
Sp. Šklendrovec, WM00, 23. 7. 1991, V. Furlan leg.
Idrija, Čekovnik, Tratnik, VL19, 20. 7. 1991, V. Furlan leg.
Ljubljana, Golovec, VL69, 16. 9. 1995, V. Furlan leg.
Bled: Zaka, VM23, 7. 1996, V. Furlan leg.

Rhaphigaster nebulosa (Poda, 1761)
Gogala & Moder, 1960: Ljubljana, Sečovlje; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Laibach (= Ljubljana), 15. 9. 1929, 25. 2. 1931, Staudacher leg.
Ljubljana: Vižmarje, VM50, 25. 10. 1929, Staudacher leg.
Ljubljana, 5. 10. 1954, M. Gogala leg., 8. 10. 1977, A. & M. Gogala leg., VM60, 8. 9. 2000, V. Furlan leg.
Portorož, UL94, 7. 1. 1979, A. & M. Gogala leg.
Ljubljansko barje: Log, Lukovica, VL59, 31. 10. 1982, A. & M. Gogala leg.
Ankaran, VL04, 17. 2. 1988, A. & M. Gogala leg.
Ajdovščina, Planina, VL17, 25. 3. 1988, A. & M. Gogala leg.
Istra: Koštabona, Supotski slap, VL03, 12. 10. 1988, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 7. 9. 1989, A. & M. Gogala leg.
Strunjan, Karbonar, UL94, 17. 5. 2003, A. & M. Gogala leg.
Hrastnik, WM01, 27. 3. 1998, A. Kapla leg.
Črni Kal, Socerb, VL14, 8. 5. 1990, V. Furlan leg., 4. 11. 1992, S. Gomboc & D. Kofol leg.
Podpeč, Jezero, Sv. Lovrenc, VL59, 12. 10. 2000, S. Gomboc & D. Kofol leg.
Krško, WL39, 21. 8. 2005, D. Fekonja leg.
Dolenjska: Šmarjeta, WL18, 2. 5. 1997, V. Furlan leg.
Additional record:
Gorjansko, VL07, 22. 2. 2003, photo A. Gogala

Piezodorus lituratus (Fabricius, 1794)
Piezodorus incarnatus (Germar, 1822)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Ljubljana, Črni Kal, Koper; Balarin, 1962: Markovščina; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Črni Kal, VL14, 10. 1976, M. Gogala leg.
Portorož, UL84, 7. 1. 1979, A. & M. Gogala leg.
Prekmurje: Lendava, XM15, 6. 7. 1980, A. & M. Gogala leg.
Koštabona, VL03, 25. 6. 1981, M. Gogala leg.
Ankaran, VL04, 8. 6. 1983, A. & M. Gogala leg.
Portorož, Lucija, UL94, 2. 7. 1983, A. & M. Gogala leg.
Krka, VL88, 12. 8. 1984, A. & M. Gogala leg.
Strunjan, UL94, 16. 10. 1985, A. & M. Gogala leg.
Labor, VL03, 9. 9. 1987, A. Gogala leg.
Boršt, VL03, 3. 5. 1986, A. & M. Gogala leg.
Kras: Trstelj, UL98, 13. 8. 1989, A. & M. Gogala leg.
Brje pri Komnu, VL07, 7. 9. 1989, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 18. 5. 1990, A. & M. Gogala leg.
Koper, Bertoki, Škocjanski zatok, VL04, 7. 7. 2000, A. Gogala leg.
Komen, VL07, 8. 4. 2000, A. & M. Gogala leg.
Istra: Trebeše, VL13, 14. 4. 2007, A. & M. Gogala leg.
Nova Gorica, Sabotin, UL99, 27. 5. 1997, S. Gomboc leg.
Komen, Branik, VL07, 27. 5. 1998, S. Brelih leg.
Hrpelje, Prešnica, VL14, 6. 7. 1998, 23. 5. 1999, S. Brelih leg.
Nanos, Lanišče, VL27, 2. 7. 1998, S. Gomboc leg.
Bistrica ob Sotli, WM50, 18. 5. 2000, S. Brelih leg.
Senožeče, Gabrče, VL26, 4. 11. 1992, S. Gomboc & D. Kofol leg.
Ribnica, Sodražica, VL76, 25. 6. 2005, D. Fekonja leg.
Ljubljana: Tomačevski prod, VM60, 27. 7. 2005, D. Fekonja leg.
Slavnik, Podgorje, VL14, 3. 5. 1980, V. Furlan leg.
Slavnik, VL14, 9. 6. 1979, V. Furlan leg.
Lipica, VL15, 30. 5. 1982, 25. 5. 1985, V. Furlan leg.
Novo mesto, Trška gora, WL17, 21. – 22. 5. 1983, 16. 6. 1991, V. Furlan leg.
Črni Kal, Socerb, VL14, 8. 5. 1990, V. Furlan leg.
Črnotiče, VL14, 8. 5. 1990, V. Furlan leg.
Polhograjsko hrib.: Grmada, VM40, 9. 5. 1987, V. Furlan leg.
Strunjan, rt Ronek, UL94, 3. 9. 1998, V. Furlan leg.

Dyroderes umbraculatus (Fabricius, 1775)
Dyroderes marginatus (Fabricius, 1798)
Montandon, 1886: Gorica; Protić, 1987: Podčetrtek; Gogala, 1996
Specimen examined:
Prekmurje: Gančani, WM96, 29. 4. 1993, 1. 5. 1994, S. Gomboc leg.

Sciocoris homalonotus Fieber, 1851
Montandon, 1886: Gorica; Gogala & Moder, 1960: Carniola; A. & M. Gogala, 1986, 1989
Specimens examined:
Kras: Lipica, VL15, 6. 5. 1984, A. & M. Gogala leg., 25. 5. 1985, V. Furlan leg.
Slavnik, VL14, 2. 6. 1984, A. & M. Gogala leg.
Ljubljansko barje: Bevke, VL59, 2. 2. 1985, A. & M. Gogala leg.
Istra: Boršt, VL03, 3. 5. 1986, A. & M. Gogala leg.
Dragonja, Stena, UL93, 1. 10. 1987, A. & M. Gogala leg.
Padna, UL93, 16. 6. 1984, A. & M. Gogala leg.
Brje pri Komnu, VL07, 18. 6. 1989, 31. 3. 1991, 2. 6. 1991, 28. 6. 2003, A. & M. Gogala leg.
Ljubljana: Savlje, VM60, 18. 2. 1998, M. Gogala leg.
Gorjansko, Nadrožica, VL07, 12. 6. 1999, A. & M. Gogala leg.
Kodreti, Dolanci, VL17, 2. 5. 2000, A. & M. Gogala leg.
Zazid, Zalipnik, VL13, 26. 5. 2000, A. Gogala leg.
Veliki Dol, VL07, 1. 5. 2003, A. Gogala leg.
Gorjansko, UL97, 20. 8. 2006, A. Gogala leg.
Nova Gorica, Sabotin, UL99, 15. 3. 1998, S. Gomboc leg.
Hrpelje, Prešnica, VL14, 10. 5. 1999, S. Brelih leg.
Nova Gorica, Panovec, UL98, 15. 5. 2000, S. Brelih leg.

Sciocoris macrocephalus Fieber, 1851
Gogala, 1991; A. & M. Gogala, 1994
Specimens examined:
Kras: Brje pri Komnu, VL07, 12. 6. 1989, M. Gogala leg., 18. 6. 1989, A. & M. Gogala leg.
Kraški rob: Bezovica, VL14, 14. 6. 1991, A. & M. Gogala leg.
Dolina Raše: Griže, VL16, 21. 3. 1992, A. & M. Gogala leg.
Slavnik, 800 m, VL14, 24. 6. 1999, S. Brelih leg.
Obrov, Golac, VL24, 8. 6. 2000, S. Brelih leg.
Divača, VL26, 25. 5. 1985, V. Furlan leg.
Črni Kal, Praproče, VL14, 12. 7. 1990, V. Furlan leg.

Sciocoris microphthalmus Flor, 1860
Sciocoris cerrutii Wagner, 1959
Gogala & Moder, 1960: Ljubljana – Barje; A. & M. Gogala, 1986, 1989, 1994; Protić, 1987: Podčetrtek
Specimens examined:
Ljubljana: Ježica, VM60, 8. 6. 1930, Staudacher leg.
Ig, VL69, 25. 6. 1939, Staudacher leg.
Šklendrovec, WM00, 29. 4. 1934, Staudacher leg.
Ljubljansko barje, VL69, 25. 6. 1954, M. Gogala leg.
Senožeče, VL26, 15. 4. 1979, A. & M. Gogala leg., 28. 6. 1982, M. Gogala leg.
Postojna, Zagon, VL37, 21. 9. 1983, A. & M. Gogala leg.
Brkini: Barka, VL25, 28. 7. 1984, A. & M. Gogala leg.
Artviže, VL25, 28. 7. 1984, A. & M. Gogala leg.
Podgorski kras: Petrinje, VL14, 11. 7. 1986, A. & M. Gogala leg.
Ljubljana: Savlje, VM60, 15. 4. 1987, 11. 4. 1988, A. & M. Gogala leg., 18. 2. 1998, M. Gogala leg.
Velike Bloke, VL57, 19. 4. 1987, A. & M. Gogala leg.
Prekmurje: Gomilica, XM06, 13. 6. 1987, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 11. 7. 1987, A. & M. Gogala leg.
Čaven, VL08, 11. 6. 1988, A. & M. Gogala leg.
Dolenja Bistrica, XM05, 23. 5. 1992, A. & M. Gogala leg.
Vremščica, VL26, 4. 7. 1992, A. & M. Gogala leg.
Nanos: Sv. Hieronim, VL27, 25. 7. 1992, A. & M. Gogala leg.
Pohorje: Rogla, WM24, 24. 7. 1993, A. & M. Gogala leg.
Zazid, Zalipnik, VL13, 26. 5. 2000, A. Gogala leg.
Rob, Uzmani, VL67, 20. 6. 1998, S. Brelih leg.
Sočerga, Šeki, VL13, 14. 6. 1999, S. Brelih leg.
Obrov, Golac, VL24, 8. 6. 2000, S. Brelih leg.
Senožeče, Gabrče, VL26, 20. 6. 1982, V. Furlan leg.
Novo mesto, Trška gora, WL17, 21. – 22. 5. 1983, V. Furlan leg.
Polhograjsko hrib.: Topol, Osredek, VM50, 3. 6. 1984, V. Furlan leg.
Kras: Povir, VL16, 16. 5. 1984, V. Furlan leg.
Gornji Ig, VL68, 23. 5. 1987, V. Furlan leg.
Kum, WM00, 20. 7. 1987, V. Furlan leg.
Črni Kal, Praproče, VL14, 12. 7. 1990, V. Furlan leg.

Sciocoris umbrinus (Wolff, 1804)
Sciocoris brevicollis Fieber, 1851
A. & M. Gogala, 1986; Gogala, 1996
Specimens examined:
Julijske Alpe: Narodni park (Triglavska jezera), VM03, 20. 7. 1933, M. Hafner leg.
Sorica, Soriška planina, VM22, 23. 6. 1984, A. & M. Gogala leg.
Vremščica, VL26, 2. 11. 1996, A. Gogala leg.
Zg. Radovna, 750 m, VM14, 22. 7. 1988, V. Furlan leg.

Sciocoris maculatus Fieber, 1851
Fieber, 1861: Krain (= Carniola).
<u>Note:</u> In the description, Fieber (1851) listed Kärnthen (Carinthia) among countries of origin of the type series, beside Italy and Dalmatia. In 1861, he substituted Carinthia with Krain (Carniola). Both localities are dubious, since this Mediterranean species has never again been found so far to the north. A similar species, *Sciocoris sideritidis*, is known to live in the territory of Carniola (Slovenia). It was not described at the time of Fieber's description and it is possible that Fieber inclu-deed specimens of *S. sideritidis* in the syntype series of *S. maculatus*.

Sciocoris sideritidis Wollaston, 1858
Sciocoris fumipennis Puton, 1881
Horváth, 1887a: Gorica; Gogala, 1996; Derjanschi & Péricart, 2005: Tolmin
Specimens examined:
Kranjska Gora, 700 m, 10. 7. 1986, H. Günther leg.

Sciocoris cursitans (Fabricius, 1794)
Sciocoris terreus (Schrank, 1801)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Dol pri Lj., Bohinj, Kot, Šklendrovec; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Kottal (= dolina Kot), VM14, 9. 6. 1935, Staudacher leg.
Šklendrovec, WM00, 29. 4. 1934, Staudacher leg.
Črni Kal, VL14, 28. 6. 1980, A. & M. Gogala leg.
Dragonja, Stena, UL93, 1. 10. 1987, A. & M. Gogala leg.
Istra: Kubed, VL14, 16. 4. 1988, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 12. 6. 1989, M. Gogala leg.
Sočerga, Veli Badin, VL13, 9. 6. 1990, A. & M. Gogala leg.
Slavnik, VL14, 19. 6. 1995, M. Gogala leg., 23. 6. 1991, V. Furlan leg.
Trstelj, UL98, 27. 8. 2000, A. & M. Gogala leg.
Brkini: Slivje, VL24, 28. 7. 1984, A. & M. Gogala leg.
Bohinj: Ukanc, VM02, 5. 7. 1986, A. & M. Gogala leg.
Hrpelje, Prešnica, VL14, 6. 7. 1998, 23. 5. 1999, S. Brelih leg.
Polhograjsko hrib.: Topol, Osredek, VM50, 3. 6. 1984, V. Furlan leg.
Sežana, Štorje, VL16, 16. 5. 1984, V. Furlan leg.
Radovna, VM24, 14. 5. 1983, V. Furlan leg.

Sciocoris distinctus Fieber, 1851
Fieber, 1851: Krain (= Carniola) – type locality

Sciocoris sulcatus Fieber, 1851
Specimen examined:
Istra: Padna, UL93, 1. 2. 1997, A. & M. Gogala leg.
Additional record:
Sečovlje, Fontanigge, UL93, 20. 6. 2001, H. Günther leg.

Eurydema oleracea (Linnaeus, 1758)
Montandon, 1886: Gorica; Gogala & Moder, 1960; Balarin, 1962: Radeče; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Laibach (= Ljubljana), 9. 5. 1929, Staudacher leg.
Veldes (= Bled), VM33, 2. 8. 1931, Staudacher leg.
Bohinj: Ukanc, VM02, 4. 6. 1978, 3. 7. 1978, 9. 8. 1978, 10. 9. 1978, A. & M. Gogala leg.
Radovljica, Brezje, VM43, 24. 4. 1979, A. & M. Gogala leg.
Škofja Loka, VM41, 13. 5. 1979, A. & M. Gogala leg.
Ljubljansko barje: Ig, Kremenica, VL68, 1. 8. 1976, S. Brelih leg.
Ljubljana: Šiška, VM50, 19. 8. 1981, A. Gogala leg.
Grosuplje, Velike Lipljene, VL78, 30. 8. 1981, A. & M. Gogala leg.
Portorož, Lucija, UL94, 2. 7. 1983, A. & M. Gogala leg.
Rovte, VL39, 22. 7. 1983, A. & M. Gogala leg.
Jezersko, VM64, 14. 8. 1983, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 7. 8. 1983, A. & M. Gogala leg.
Polhograjsko hrib.: Črni Vrh, VM40, 4. 8. 1983, A. & M. Gogala leg.
Ljubljana: Savlje, VM60, 19. 4. 1984, A. & M. Gogala leg.
Sorica, Soriška planina, VM22, 23. 6. 1984, A. & M. Gogala leg.
Istra: Marezige, VL04, 7. 9. 1985, A. Gogala leg.
Strunjan, UL94, 16. 10. 1985, A. & M. Gogala leg.
Čaven, VL08, 11. 6. 1988, A. & M. Gogala leg.
Zg. Radovna, VM14, 28. 8. 1988, A. & M. Gogala leg.
Bela krajina: Drašiči, Babna Gora, WL25, 13. 8. 1988, M. Štangelj leg.
Log, Dragomer, VL59, 25. 7. 1980, A. & M. Gogala leg.
Osp, VL14, 8. 7. 1990, A. & M. Gogala leg.
Nanos: Sv. Hieronim – Pleša, VL27, 4. 7. 1998, A. Gogala leg.
Ig, Iška Loka, VL69, 17. 8. 1997, S. Brelih leg.
Ig, Kremenica, VL68, 5. 8. 1997, S. Brelih leg.
Murski Petrovci, WM86, 31. 7. 1998, S. Brelih leg.
Podsreda, Trebča Gorca, WM40, 9. 7. 1998, S. Brelih leg.
Hrastje-Mota, WM86, 24. 5. 1994, B. Drovenik leg.
G. Radgona, Podgrad, WM77, 10. 5. 1994, B. Drovenik leg.
Prekmurje: Bukovnica, XM07, 2. 6. 1999, S. Brelih leg.
Ilirska Bistrica, Zarečje – Brce, VL34, 31. 5. 1999, S. Brelih leg.
Čaven: pl. koča, VL18, 1240 m, 27. 5. 1999, S. Brelih leg.
Nova Gorica, Panovec, UL98, 15. 5. 2000, S. Brelih leg.
Dragonja, UL93, 4. 5. 2000, S. Brelih leg.
Kamniške Alpe: Krvavec, Sv. Ambrož, 1100 m, VM62, 24. 5. 2001, S. Brelih leg.
Ljubljana: Bežigrad, VM60, 3. 6. 2005, D. Fekonja leg.
Ig, Mokrec, 900 m, VL68, 9. 8. 1982, V. Furlan leg.
Bela krajina: Žuniči, WL23, 27. 4. 1983, V. Furlan leg.
Bela krajina: Stranska vas, WL15, 28. 4. 1983, V. Furlan leg.
Podzemelj, WL25, 28. 4. 1983, V. Furlan leg.
Vinica, WL13, 29. 4. 1983, V. Furlan leg.
Suha krajina: Žvirče, VL87, 7. 5. 1983, V. Furlan leg.
Muljava, VL88, 7. 5. 1983, V. Furlan leg.
Novo mesto, Trška gora, WL17, 21. – 22. 5. 1983, V. Furlan leg.
Radovna, VM24, 14. 5. 1983, V. Furlan leg.
Polhov Gradec, VM40, 6. 5. 1984, V. Furlan leg.

Unec, VL47, 25. 5. 1985, V. Furlan leg.
Ljubljana, Golovec: Orle, VL69, 20. 5. 1984, V. Furlan leg.
Topol, Osredek, VM50, 3. 6. 1984, V. Furlan leg.
Divača, VL26, 25. 5. 1985, V. Furlan leg.
Kum, WM00, 4. 6. 1988, V. Furlan leg.
Krim, 950 m, VL58, 23. 5. 1987, V. Furlan leg.
Senožeče, Gabrče, VL26, 26. 5. 1987, V. Furlan leg.
Zg. Hotič, VM80, 28. 5. 1987, V. Furlan leg.
Prekmurje: Renkovci, WM96, 24. 5. 1989, S. Brelih leg.
Orešje na Bizeljskem, WM50, 25. 5. 1993, V. Furlan leg.
Velike Lašče, Rašica, VM77, 29. 6. 1993, V. Furlan leg.
Kozjansko: Sedlarjevo, WM40, 23. 6. 1993, V. Furlan leg.
Kozina, VL15, 22. 6. 1991, V. Furlan leg.
Postojna, VL37, 10. 6. 1991, V. Furlan leg.
Cerkniško jezero: Goričica, VL56, 10. 6. 1991, V. Furlan leg.
Terme Čatež, WL48, 25. 4. 1998, V. Furlan leg.
Loški potok: Retje, VL66, 27. 5. 1998, V. Furlan leg.
Strunjan, rt Ronek, UL94, 3. 9. 1998, V. Furlan leg.

Eurydema ornata (Linnaeus, 1758)
Strachia decorata (Herrich-Schaeffer, 1833)
Scopoli, 1763: Lipica; Montandon, 1886: Gorica; Gogala & Moder, 1960: Ljubljana, Šmartno ob Savi, Koper, Strunjan; Balarin, 1962: Radeče; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Piran, UL84, 30. 9. 1979, A. & M. Gogala leg., 3. 10. 1986, M. Gogala leg.
Portorož, Lucija, UL94, 2. 7. 1983, A. & M. Gogala leg.
Strunjan, UL94, 16. 10. 1985, A. & M. Gogala leg.
Dragonja, Stena, UL93, 1. 10. 1987, 30. 8. 1989, A. & M. Gogala leg.
Kras: Komen, Nadrožica, VL07, 5. 5. 1989, A. & M. Gogala leg.
Osp, VL14, 8. 7. 1990, A. & M. Gogala leg.
Lipica, VL15, 16. 5. 1992, A. & M. Gogala leg.
Sečovlje, Fontanigge, UL93, 14. 9. 1996, A. Gogala leg.
Koper, Bertoki, Škocjanski zatok, VL04, 6. 5. 2000, A. Gogala leg.
Gorjansko, Parti, UL97, 29. 8. 2004, A. Gogala leg.
Istra: Popetre, VL13, 9. 7. 1997, S. Brelih leg.
Hrastovlje, VL14, 23. 4. 1998, S. Gomboc & D. Kofol leg.

Eurydema fieberi Fieber, 1837
A. & M. Gogala, 1989; A. Gogala, 1992
Specimens examined:
Čaven: Kucelj, VL08, 11. 6. 1988, A. & M. Gogala leg.
Kovk, Sinji vrh, 960 m, VL18, 29. 5. 1999, A. & M. Gogala leg.

Eurydema rutundicollis (Dohrn, 1860)
A. & M. Gogala, 1986, 1989
Specimens examined:
Žirovnica, Završnica, VM34, 22. 5. 1921, M. Hafner leg.
Sorica, Soriška planina, VM22, 23. 6. 1984, A. & M. Gogala leg.
Črna na Koroškem, VM84, 25. 6. 1987, N. Gogala leg.
Triglav, Rudno polje – Planika, 1500 – 2400 m, VM13, 5. 8. 1991, E. Holzer leg.
Konjsko sedlo pod Bohinjskim Migovcem, 1780 m, VM02, 1. 9. 1984, V. Furlan leg.

Eurydema dominulus (Scopoli, 1763)
Scopoli, 1763: Carniola – type region; Gogala & Moder, 1960: Ljubljana, Šmartno ob Savi, Bohinj; Balarin, 1962: Hraše; A. & M. Gogala, 1986, 1989; Protić, 1987: Kamnik
Specimens examined:
Laibach (= Ljubljana), 14. 7. 1929, 3. 8. 1929, Staudacher leg.
Ljubljana: Šiška, VM50, 1. 6. 1978, A. & M. Gogala leg.
Bohinj: Ukanc, VM02, 4. 6. 1978, A. & M. Gogala leg.
Ljubljana, Sostro, VL79, 21. 6. 1979, A. & M. Gogala leg.
Ig, Kremenica, VL68, 6. 9. 1975, 29. 8. 1976, 24. 8. 1978, S. Brelih leg.
Ljubljansko barje: Bevke, VL59, 14. 6. 1980, A. & M. Gogala leg.
Dobrova, VM50, 26. 8. 1981, A. & M. Gogala leg.
Vrhnika, VL49, 11. 7. 1982, A. & M. Gogala leg.
Medvode, Sora, Draga, VM51, 22. 7. 1982, A. & M. Gogala leg.
Ljubljana, Mestni log, VL59, 14. 5. 1983, A. & M. Gogala leg.
Postojna, Landol, VL37, 21. 9. 1983, A. & M. Gogala leg.
Žužemberk, VL97, 5. 3. 1989, A. & M. Gogala leg.
Gradišče pri Lukovici, VM71, 11. 7. 1996, A. Gogala leg.
Rakov Škocjan, VL47, 6. 6. 1998, A. Gogala leg.
Kranj, Brdo, VM52, 31. 8. 2006, A. Gogala leg.
Ljubljana, Golovec: Orle, VL69, 13. 3. 1991, V. Furlan leg.
Podkum, Medvedov graben, WM00, 16. 4. 1991, V. Furlan leg.
Zasavje: Renke, VM90, 25. 6. 1991, V. Furlan leg.
Brezje pri Dobrovi, VL49, 5. 7. 1977, V. Furlan leg.
Borovak pri Podkumu, WM00, 30. 4. 1990, V. Furlan leg.
Ljubljana, Lavrica, VL69, 29. 4. 1991, V. Furlan leg.
Additional records:
Dol pri Ljubljani, VM70, 12. 5. 2006, photo A. Gogala
Cerkniško jezero: Cerknica, Dolenja vas, VL47, 8. 9. 2007, photo A. Gogala

Eurydema ventralis Kolenati, 1846
Montandon, 1886: Gorica (as *Strachia ornata*); Gogala & Moder, 1960: Ljubljana, Rašica, Dobrova, Mavrlen, Črni Kal; Balarin, 1962: Radeče; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Bela krajina: Meierle (= Mavrlen), WL14, 7. 5. 1933, Staudacher leg.
Laibach (= Ljubljana), 25. 11. 1929, Staudacher leg.
Bohinj: Ribčev laz, VM12, 5. 9. 1935, M. Hafner leg.
Ljubljana: Šiška, VM50, 8. 5. 1977, 1. 6. 1978, A. & M. Gogala leg.
Ljubljansko barje: Log, Lukovica, VL59, 16. 5. 1982, A. & M. Gogala leg.
Istra: Dragonja, Stena, UL93, 1. 10. 1987, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 16. 7. 1989, A. & M. Gogala leg.
Osp, VL14, 8. 7. 1990, A. Gogala leg.
Koper, Bertoki, Škocjanski zatok, VL04, 6. 5. 2000, A. Gogala leg.
Ig, Iška vas, VL68, 10. 8. 1974, V. Furlan leg.
Slavnik, VL14, 9. 6. 1979, V. Furlan leg.
Divača, VL26, 30. 5. 1982, V. Furlan leg.
Ljubljana, Golovec: Orle, VL69, 20. 5. 1984, V. Furlan leg.
Bela krajina: Črnomelj, Veliki Nerajec, WL14, 29. 4. 1983, V. Furlan leg.
Novo mesto, Trška gora, WL17, 21. – 22. 5. 1983, V. Furlan leg.
Unec, VL47, 25. 5. 1985, V. Furlan leg.
Podkum, Medvedov graben, WM00, 10. 5. 1989, V. Furlan leg.
Additional record:
Gorjansko, Nadrožica, VL07, 23. 4. 2006, photo A. Gogala

Podopinae

Ancyrosoma leucogrammes (Gmelin, 1790)
Ancyrosoma albolineatum (Fabricius, 1781)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Črni Kal; Gogala, 1991, 1992
Specimens examined:
Istra: Dragonja, Stena, UL93, 30. 8. 1989, A. & M. Gogala leg.
Strunjan, UL94, 11. 9. 1995, A. & M. Gogala leg.
Padna, UL93, 19. 8. 1996, A. & M. Gogala leg.
Kras: Brje pri Komnu, VL07, 12. 9. 1999, A. Gogala leg.
Nanos: Sv. Hieronim, VL27, 8. 8. 2000, A. Gogala leg.
Additional records:
Gorjansko, UL97, 17. 8. 2002, photo A. Gogala
Tublje pri Komnu, VL07, 14. 8. 2005, photo A. Gogala

Graphosoma lineatum (Linnaeus, 1758)
Graphosoma italicum (Müller, 1766)
Scopoli, 1763: Lipica; Montandon, 1886: Gorica; Kormilev, 1929: Ptuj; Gogala & Moder, 1960: Ljubljana, Šmartno ob Savi, Lancovo, Bled, Šklendrovec, Gorjanci, Slavnik; Balarin, 1962: Mežica; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Radovljica, Lancovo, VM33, 4. 8. 1929, Staudacher leg.
Veldes (= Bled), VM33, 19. 7. 1931, Staudacher leg.
Šklendrovec, WM00, 12. 6. 1932, Staudacher leg.
Ljubljana, Črnuče, VM60, 3. 6. 1979, A. & M. Gogala leg.
Ig, Kremenica, VL68, 12. 6. 1976, 19. 6. 1976, S. Brelih leg.
Portorož, Beli Križ, UL84, 3. 10. 1979, M. Gogala leg.
Kras: Škocjan, VL25, 27. 6. 1981, A. & M. Gogala leg.
Grosuplje, Velike Lipljene, VL78, 30. 8. 1981, A. & M. Gogala leg.
Kamnik pod Krimom, Ponikve, VL58, 20. 6. 1982, A. & M. Gogala leg.
Senožeče, VL26, 28. 6. 1982, M. Gogala leg.
Medvode, Sora, Draga, VM51, 22. 7. 1982, A. & M. Gogala leg.
Ljubljansko barje: Log, Lukovica, VL59, 14. 5. 1983, A. & M. Gogala leg.
Ilirska Bistrica, Jelšane, VL43, 21. 6. 1983, M. Gogala leg.
Istra: Kubed, VL14, 24. 7. 1984, A. & M. Gogala leg.
Krka, VL88, 12. 8. 1984, A. & M. Gogala leg.
Piran, UL84, 3. 10. 1986, M. Gogala leg.
Pomurje: Veržej, WM86, 13. 6. 1987, A. & M. Gogala leg.
Goričko: Fikšinci, WM78, 14. 6. 1987, A. & M. Gogala leg.
Bloke: Volčje, Bloško jezero, VL67, 11. 7. 1987, A. & M. Gogala leg.
Idrija, Krekovše, VL19, 28. 6. 1988, M. Gogala leg.
Bohinj: Ukanc, VM02, 10. 7. 1988, A. & M. Gogala leg.
Šmarje pri Jelšah, WM42, 17. 8. 1988, A. & M. Gogala leg.
Bela krajina: Drašiči, Babna Gora, WL25, 13. 8. 1988, M. Štangelj leg.
Cerkniško jezero: Dolenje Jezero, VL56, 10. 9. 1988, A. & M. Gogala leg.
Brje pri Komnu, VL07, 5. 5. 1989, A. & M. Gogala leg.
Sočerga, Veli Badin, VL13, 18. 5. 1990, A. & M. Gogala leg.
Dragonja, Stena, UL93, 9. 6. 1990, A. & M. Gogala leg.
Ilirska Bistrica, Štanga, VL44, 22. 7. 1992, A. & M. Gogala leg.
Julijske Alpe: Vas na skali, VM03, 11. 6. 1997, S. Brelih leg.

Hrpelje, Prešnica, VL14, 18. 7. 1998, S. Brelih leg.
Nanos: Šembijska bajta, 800 m, VL27, 14. 7. 1999, S. Brelih leg.
Nova Gorica, Panovec, UL98, 15. 5. 2000, S. Brelih leg.
Ribnica, Sodražica, VL76, 29. 5. 2005, D. Fekonja leg.
Slavnik, VL14, 9. 6. 1979, V. Furlan leg.
Julijske Alpe: Črna prst, VM12, 4. 7. 1976, V. Furlan leg.
Sp. Brnik, VM62, 22. 6. 1975, V. Furlan leg.
Polhograjsko hrib.: Grmada, VM40, 25. 5. 1979, M. Zdešar leg.
Novo mesto, Trška gora, WL17, 21. – 22. 5. 1983, V. Furlan leg.
Ljubljana, Golovec, VL69, 18. 6. 1982, V. Furlan leg.
Bela krajina: Podzemelj, WL25, 28. 4. 1983, V. Furlan leg.
Ig, Kurešček, VL68, 5. 6. 1983, V. Furlan leg.
Kras: Povir, VL16, 31. 7. 1984, V. Furlan leg.
Kum, WM00, 20. 7. 1987, V. Furlan leg.
Vinica, WL13, 11. 7. 1989, V. Furlan leg.
Muljava, VL88, 12. 8. 1998, V. Furlan leg.
Kozjansko: Sedlarjevo, WM40, 23. 6. 1993, V. Furlan leg.

Graphosoma semipunctatum (Fabricius, 1775)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Slavnik
Specimens examined:
Istra: Sočerga, Gradec, VL13, 1. 8. 2000, A. Gogala leg.
Zazid, Lipnik, 720 m, VL13, 9. 8. 2005, A. Gogala leg.

Sternodontus obtusus Mulsant & Rey, 1856
Sternodontus debilicostis Puton, 1884
Montandon, 1886: Kras (Karst) near Gorica; A. & M. Gogala, 1986, 1994; A. Gogala, 1992; Protić, 2001: Gorica
Specimens examined:
Kraški rob: Črni Kal, VL14, 28. 6. 1980, A. & M. Gogala leg.
Podgorje, VL14, 24. 8. 1991, A. & M. Gogala leg.
Ilirska Bistrica, Štanga, VL44, 22. 7. 1992, A. & M. Gogala leg.
Kras: Lukovec, Golec, VL07, 24. 7. 2005, A. Gogala leg.

Tholagmus flavolineatus (Fabricius, 1798)
Gogala, 1996
Specimens examined:
Istra: Dragonja, Stena, UL93, 23. 8. 1995, 11. 9. 1995, A. & M. Gogala leg.

Ventocoris rusticus (Fabricius, 1781)
Gogala *et al.*, 2007
Specimen examined:
Istra: Dragonja, Stena, UL93, 26. 5. 2007 on *Nigella damascena*, A. Gogala leg. (Fig. 2)

Fig. 2: *Ventocoris rusticus* ***(Fabricius) couple on*** *Nigella damascena* ***at Stena near Dragonja.***
Sl. 2: Par vrste *Ventocoris rusticus* ***(Fabricius) na vzhodni črniki na Steni pri Dragonji.***

Vilpianus galii (Wolff, 1802)
Montandon, 1886: Gorica; A. & M. Gogala, 1986, 1989, 1994
Specimens examined:
Kraški rob: Črni Kal, VL14, 9. 7. 1980, 8. 6. 1983, A. & M. Gogala leg.
Sečovlje, UL93, 20. 9. 1980, A. & M. Gogala leg.
Koštabona, VL03, 25. 6. 1981, M. Gogala leg., 7. 6. 1987, A. & M. Gogala leg.
Koper, Sermin, VL04, 16. 6. 1984, A. & M. Gogala leg.
Sočerga, VL13, 7. 9. 1985, A. & M. Gogala leg.
Dragonja, Stena, UL93, 9. 6. 1990, 6. 5. 2000, A. & M. Gogala leg.
Črnotiče, VL14, 8. 7. 1990, A. & M. Gogala leg.
Zazid, Zalipnik, VL13, 26. 5. 2000, A. Gogala leg.
Istra: Kozloviči, VL03, 9. 7. 1997, S. Brelih leg.
Sočerga, Šeki, VL13, 17. 6. 1999, S. Brelih leg.

Podops inunctus (Fabricius, 1775)
Montandon, 1886: Gorica; Gogala & Moder, 1960: Ljubljana; A. & M. Gogala, 1986, 1989, 1994; Protić, 1987: Podčetrtek
Specimens examined:
Laibach (= Ljubljana), 30. 9. 1928, 20. 10. 1928, 15. 9. 1929, 1. 6. 1937, Staudacher leg.

Ljubljana, Tacen, VM50, 2. 3. 1980, 26. 10. 1980, A. & M. Gogala leg.
Ljubljana: Savlje, VM60, 19. 4. 1984, A. & M. Gogala leg.
Črni Kal, VL14, 28. 6. 1980, A. & M. Gogala leg.
Ljubljansko barje: Log, Lukovica, VL59, 11. 10. 1984, 24. 7. 1986, A. & M. Gogala leg.
Kostel: Fara, VL93, 26. 6. 1994, A. & M. Gogala leg.
Šentjakob ob Savi, VM60, 9. 11. 1996, A. & M. Gogala leg.
Istra: Portorož, Lucan, UL94, 27. 4. 1999, A. Kapla leg.
Koper, Bertoki, Škocjanski zatok, VL04, 6. 5. 2000, A. Gogala leg.
Kras: Komen, VL07, 8. 4. 2000, A. & M. Gogala leg.
Brje pri Komnu, VL07, 26. 4. 2000, A. & M. Gogala leg.
Planinsko polje: Planina, VL47, 11. 7. 2001, A. Gogala leg.
Ig, Iška Loka, VL69, 3. 4. 1997, S. Brelih leg.
Nova Gorica, Panovec, UL98, 21. 4. 2000, S. Brelih leg.
Polhov Gradec, VM40, 6. 5. 1984, V. Furlan leg.
Ljubljana, Golovec: Orle, VL69, 20. 5. 1984, 13. 5. 1991, V. Furlan leg.
Muljava, VL88, 11. 5. 1985, V. Furlan leg.
Polhograjsko hrib.: Topol, Osredek, VM50, 12. 5. 1985, V. Furlan leg.
Zasavje: Renke, VM90, 13. 9. 1991, V. Furlan leg.

Dybowskyia reticulata (Dallas, 1851)
Gogala, 1991, 1992
Specimens examined:
Ilirska Bistrica, Štanga, VL44, 8. 7. 1989, S. Brelih leg.
Čaven: pl. koča, 1240 m, VL18, 27. 5. 1999, S. Brelih leg.

Species omitted from the list

Aelia sibirica Reuter, 1884
Aelia henschi Montandon, 1886
Montandon, 1886: Gorica – type locality of *A. henschi*
Montandon described *A. henschi* on the basis of a single specimen collected by Schreiber in the environment of Gorica (Gorizia) and three specimens collected by Hensch near Monfalcone. Horváth (1887b) mentioned only the latter locality as the type locality, and like him we can suspect that Schreiber also collected the species at the coast and the town Gorica is mentioned only in a very broad sense, as a larger centre. If that is correct, the specimen was not found within the borders of Slovenia.

Eurydema spectabilis Horváth, 1882
Gogala & Moder, 1960: Vikrče. It is unlikely for this Pontic species to be present in Slovenia. Probably a misidentification.

Addition to Part I (A. Gogala, 2003b)

SALDIDAE

Saldula arenicola (Scholtz, 1847)
Specimens examined:
Bistrica ob Sotli, WM50, 25. 5. 1993, V. Furlan leg.
Dol pri Ljubljani, ob Savi, VM70, 28. 7. 2006, A. Gogala leg.

Addition to Part II (Gogala, 2004)

TINGIDAE

Acalypta pulchra Štusák, 1961
Kment *et al.*, 2003: Gornje Jezersko
I overlooked this record. The status of this taxon, however, should be cleared. The validity of the species is questionable, considering that many intermediate forms between *A. pulchra* and *A. musci* exist.

Dictyla nassata (Puton, 1874)
Specimens examined:
Sela na Krasu, UL97, 29. 4. 2007 on *Onosma javorkae*, A. Gogala leg.

MICROPHYSIDAE

Loricula pselaphiformis Curtis, 1833
H. Günther sent me his record from the Cerknica lake:
Cerknica, Dolenje Jezero, VL57, 23. 6. 2001, H. Günther leg.

NABIDAE

Nabis ericetorum Scholtz, 1847
Specimens examined:
Kranj, Brdo, VM52, 31. 8. 2006 on *Calluna vulgaris*, 12. 9. 2007 on *Calluna*, A. Gogala leg. (Fig. 3)

REDUVIIDAE

Coranus subapterus (De Geer, 1773)
Specimen examined:
Vremščica, 880 m, VL26, 21. 7. 2007, A. & M. Gogala leg.

Addition to Part III (A. Gogala, 2006)

MIRIDAE

Chlamydatus pullus (Reuter, 1870)
C. Rieger sent me his records from the Kras:
Lipica, VL15, 18. 7. 1988, 26. 5. 1996, C. Rieger leg.

Fig. 3: *Nabis ericetorum* **Scholtz female on** *Calluna vulgaris* **at Brdo near Kranj.**
Sl. 3: Samica male plenilke vrste *Nabis ericetorum* **Scholtz na jesenski vresi na Brdu pri Kranju.**

Psallus albicinctus (Kirschbaum, 1856)
Specimens examined:
Kranj, Brdo, VM52, 9. 6. 2006 on *Quercus*, A. Gogala leg.

DISCUSSION

45 species of the Coreoidea and 96 species of the Pentatomoidea are listed for Slovenia, altogether 141 species. The families presented are Stenocephalidae (4 species), Rhopalidae (15), Alydidae (4) and Coreidae (22) within the Coreoidea and Cydnidae (14), Thyreocoridae (1), Plataspidae (1), Acanthosomatidae (7), Scutelleridae (8) and Pentatomidae (65 species) within the Pentatomoidea. The presence of some species, however, is dubious. *Dicranocephalus marginicollis* (Puton, 1881) has not been found since Horváth described *Stenocephalus pruinosus*, its synonym, in 1887 on a specimen from Razdrto. *Rhopalus lepidus* Fieber, 1861 and *R. rufus* Schilling, 1829 were recorded only as forms of *R. parumpunctatus*, which is a widely distributed species. I have not found any material that would prove the presence of these species in Slovenia. The exact locality where F.J. Schmidt found *Haploprocta sulcicornis* (Fabricius, 1794) is not recorded by him. It could be out of the present borders of Slovenia, which could also be the case of the record of *Acrosternum millierei* (Mulsant & Rey, 1866) from Gorica (Gorizia) by A. Montandon. *Sciocoris maculatus* Fieber, 1851 has not been found since Fieber's description. Actually, the syntype material from Carniola could be *Sciocoris sideritidis* as well, as it was not recognized yet at the time. *Sciocoris distinctus* Fieber, 1851 was also recorded only in the original description. But some other species have also been recorded only once in Slovenia. They could be very rare or just occasional immigrants. Some Mediterranean species have been discovered for the first time only in recent years, for example *Psacasta exanthematica* (Scopoli, 1763), *Neottiglossa bifida* (A. Costa, 1847) and *Ventocoris rusticus* (Fabricius, 1781). We can be quite certain that mild winters, a consequence of global warming, allowed them to spread north. Some other species, on the other hand, are probably extinct or highly endangered now because of the urbanization of their habitats. *Centrocoris variegatus* Kolenati, 1845 has not been found since the early eighties and *Microporus nigrita* (Fabricius, 1794) even for a longer time. Both lived in the areas that are largely urbanized now, the first at the coast and the other along the Sava river near the capital city.

With the additional 8 records published above, the total number of the Heteroptera species listed for Slovenia has now reached 734.

ACKNOWLEDGEMENTS

I am grateful to Hannes Günther, Petr Kment and Christian Rieger for sending me records of the species collected in Slovenia.

HETEROPTERA SLOVENIJE, V: PENTATOMOMORPHA II IN DODATKI K PREJŠNJIM DELOM

Andrej GOGALA
Prirodoslovni muzej Slovenije, Prešernova 20, p.p. 290, SI-1001 Ljubljana, Slovenija
E-mail: agogala@pms-lj.si

POVZETEK

Naštete so vrste naddružin Coreoidea in Pentatomoidea, ki živijo v Sloveniji. Navedeni so podatki o pregledanih primerkih. Sedem vrst je prvič zabeleženih v slovenski favni: Coriomeris affinis *(Herrich-Schaeffer, 1839),* Geotomus elongatus *(Herrich-Schaeffer, 1840),* Psacasta exanthematica *(Scopoli, 1763),* Neottiglossa bifida *(A. Costa, 1847),* Neottiglossa lineolata *(Mulsant & Rey, 1852),* Acrosternum heegeri Fieber, *1861 in* Sciocoris sulcatus *Fieber, 1851. Vrsta* Ventocoris rusticus *(Fabricius, 1781) je bila najdena šele leta 2007. Poročamo tudi o nekaterih dodatnih vrstah v Sloveniji iz družin, obdelanih v prejšnjih prispevkih:* Saldula arenicola *(Scholtz, 1847),* Dictyla nassata *(Puton, 1874),* Loricula pselaphiformis *Curtis, 1833,* Nabis ericetorum *Scholtz, 1847,* Coranus subapterus *(De Geer, 1773),* Chlamydatus pullus *(Reuter, 1870) in* Psallus albicinctus *(Kirschbaum, 1856).*

Ključne besede: Heteroptera, Pentatomomorpha, Coreoidea, Pentatomoidea, favna, Slovenija

REFERENCES

Balarin, I. (1962): 1. prilog fauni Pentatomoidea (Hemiptera-Heteroptera) Jugoslavije. Acta Instituti protectionis plantarum Facultatis agronomicae, Zagreb, 2, 1–21.

Belousova, E. N. (2007): Revision of the Shield-bug Genera *Holcostethus* Fieber and *Peribalus* Mulsant et Rey (Heteroptera, Pentatomidae) of the Palaearctic Region. Entomologicheskoe Obozrenie, 86(3), 610–654. [in Russian; Engl. transl.: 2007, Entomol. Rev., 87(6), 701–739].

Derjanschi, V. & J. Péricart (2005): Hémiptères Pentatomoidea Euro-Méditerranéens, Vol. 1. Faune de France 90. FFSSN, Paris, 494 p.

Fieber, F. X. (1851): Rhynchotographien. Abhandlungen der Böhmischen Gesellschaft der Wissenschaften (5) 7 (1852), pp. 425–488.

Fieber, F. X. (1861): Die europäischen Hemiptera. Halbflügler (Rhynchota Heteroptera), nach der analytischen Method bearbeitet. Wien.

Floren, A. & A. Gogala (2002): Heteroptera from beech (*Fagus sylvatica*) and silver fir (*Abies alba*) trees of the primary forest reserve Rajhenavski Rog, Slovenia. Acta Entomol. Slov., 10, 25–32.

Gogala, A. (1991): New records for the Heteroptera fauna of Slovenia (Yugoslavia). Biolo. Vestn., 39, 149–156.

Gogala, A. (1992): Rdeči seznam ogroženih stenic (Heteroptera) v Sloveniji (The Red list of endangered Heteroptera in Slovenia. Varstvo narave, 17, 117–121.

Gogala, A. (1996): New records for the Heteropteran fauna of Slovenia II. Acta Entomol. Slov., 4, 31–36.

Gogala, A. (2003a): Listonožka *(Leptoglossus occidentalis)* že v Sloveniji (Heteroptera: Coreidae). Acta Entomol. Slov., 11(2), 189–190.

Gogala, A. (2003b): Heteroptera of Slovenia, I: Dipsocoromorpha, Nepomorpha, Gerromorpha and Leptopodomorpha. Annales, Ser. Hist. Nat., 13(2), 229–240.

Gogala, A. (2004): Heteroptera of Slovenia, II: Cimicomorpha I. Annales, Ser. Hist. Nat., 14 (2), 237–258.

Gogala, A. (2006): Heteroptera of Slovenia, III: Miridae. Annales, Ser. Hist. Nat., 16 (1), 77–112.

Gogala, A. & M. Gogala (1986): Seznam vrst stenic, ugotovljenih v Sloveniji (Checklist of bug species recorded in Slovenia) (Insecta: Heteroptera). Biol. Vestn., 34, 21–52.

Gogala, A. & M. Gogala (1989): True bugs of Slovenia (Insecta: Heteroptera). Biol. Vestn., 37, 11–44.

Gogala, A. & M. Gogala (1994): Stenice (Heteroptera) Kraškega roba. Annales, Ser. Hist. Nat., 4, 37–42.

Gogala, A., M. Gogala & H. Günther (1990): New records of *Gardena insignis* Horváth, 1887 (Emesinae, Reduviidae) in Istria (Yugoslavia). Scopolia, Suppl. 1, 65–68.

Gogala, A., I. Sivec & M. Gogala (2007): Žuželke. V: Kaligarič, M. & N. Pipenbaher (ur.): Živi svet porečja Dragonje. Fakulteta za naravoslovje in matematiko, Maribor, str. 18–21.

Gogala, M. (2003): Stenica *Leptoglossus occidentalis* je že na slovenskem Krasu. Proteus, 66(2), 80–81.

Gogala, M. (2006): Vibratory signals produced by Heteroptera – Pentatomorpha and Cimicomorpha. In: Drosopoulos, S. & M. F. Claridge (eds.): Insect sounds and communication. Physiology, behaviour, ecology and evolution. CRC (Taylor & Francis), Boca Raton, pp. 275–295.

Gogala, M. & A. Moder (1960): Prispevek k poznavanju favne stenic Slovenije (Hemiptera – Heteroptera). Biol. Vestn., 7, 85–99.

Gogala, M. & I. Hočevar (1990): Vibrational songs in three sympatric species of Tritomegas. Scopolia, Suppl. 1, 117–123.

Gogala, M., H.-S. Yong & C. Brühl, (1998): Maternal care in Pygoplatys bugs (Heteroptera: Tessaratomidae). Eur. J. Entomol., 95, 311–315.

Gräffe, E. (1911): Beiträge zur Fauna der Hemipteren des Küstenlandes. Boll. Soc. Adriat. Sci. Nat. Trieste, 15, 291–309.

Horváth, G. (1887a): Hémiptères-Hétéroptères des environs de Gorice (Illyrie). Rev. Entomol., 6, 68–74.

Horváth, G. (1887b): Note emitterologiche. Boll. Soc. Entomol. It., 19, 278–285.

Jurc, D. & M. Jurc (2005): Storževa listonožka *(Leptoglossus occidentalis*, Hemiptera: Coreidae) se hitro širi po Sloveniji. Gozdarski vestnik, 63(2), 59–67.

Kerzhner, I. M. (1976): New and little-known Heteroptera from Mongolia and from adjacent regions of the USSR, III. Nasekomye Mongolii, 4, 30–86.

Kment, P., J. Bryja, Z. Jindra, K. Hradil & P. Baňař (2003): New and interesting records of true bugs (Heteroptera) from the Czech Republic and Slovakia II. Klapalekiana, 39, 257–306.

Kormilev, N. (1929): Prilog proučavanju Hemiptera – Heteroptera Jugoslavije. Glasnik Jugoslovenskog entomološkog društva, 3–4, 79–91.

Montandon, A. L. (1885): Hémiptères-Hétéroptères de Moldavie et description de deux nouveaux Eurygaster. Rev. Entomol., 4, 164–172.

Montandon, A. (1886): Hémiptères-Hétéroptères des environs de Gorice (Illyrie) et description d'une espèce nouvelle. Rev. Entomol., 5, 105–111.

Protić, Lj. (1987): Hemiptera – Heteroptera collection of Nikolas A. Kormilev in Natural History Museum in Belgrade. Nat. Hist. Mus. Belgrade, Special issue, Vol. 35.

Protić, Lj. (2001): Catalogue of the Heteroptera fauna of Yugoslav countries, part two. Nat. Hist. Mus. Belgrade, Special issue, Vol. 39.

Reuter, O. M. (1888): Hémiptères-Hétéroptères des environs de Gorice (Illyrie). Rev. Entomol., 7, 57–61.

Ribes, J., D. A. Gapon & S. Pagola-Carte (2007): On some species of *Carpocoris* Kolenati, 1846: new synonymies. Mainzer naturwiss. Archiv, Beiheft 31, 187–198.

Rider D. A. (2006): Family Pentatomidae Leach, 1815. In: Aukema, B. & C. Rieger (eds.): Catalogue of the Heteroptera of the Palaearctic Region. Vol. 5. Pentatomomorpha II. The Netherlands Entomological Society, Amsterdam, 550 p.

Scopoli, J. A. (1763): Entomologia carniolica exhibens insecta Carnioliae indigena et distributa in ordines, genera, species, varietates. Methodo Linnaeana. Trattner, Vindobonae.

Original scientific article
Received: 2008-05-14

UDC 595.74(44-13)

ECOLOGY AND EYE MORPHOLOGY IN *BUBOPSIS AGRIONOIDES*, *PUER MACULATUS* AND *DELEPROCTOPHYLLA DUSMETI* (NEUROPTERA, ASCALAPHIDAE)

Bruno MICHEL
Centre de Coopération Internationale en Recherche Agronomique pour le Développement, TA A-55/L,
UMR CBGP, Campus International de Baillarguet, F-34398 Montpellier cedex 5, France
E-mail: bruno.michel@cirad.fr

Karl KRAL
Institute of Zoology, Karl-Franzens-University Graz, A-8010 Graz, Austria

ABSTRACT

Field observations were made on Bubopsis agrionoides, Puer maculatus *and* Deleproctophylla dusmeti *(Ascalaphidae) in the Mediterranean area of France.* B. agrionoides *and* P. maculatus *were found in the biotopes covered with* Quercus ilex, *whereas* D. dusmeti *was collected in open areas covered with low vegetation. Individuals of* B. agrionoides *and* D. dusmeti *regroup to constitute populations of variable importance, but individuals of* P. maculatus *were always observed solitarily. The daily activity period of the adults was determined only for* B. agrionoides *and* D. dusmeti. *Like the* Libelloides *species, the three species mentioned in this paper may use the dorso-frontal UV-sensitive part of their divided compound eyes for detecting preys or mates flying on blue sky background.*

Key words: owl-flies, *Deleproctophylla dusmeti*, *Bubopsis agrionoides*, *Puer maculatus*, France, ecology, eye morphology

ECOLOGIA E MORFOLOGIA OCULARE IN *BUBOPSIS AGRIONOIDES*, *PUER MACULATUS* E *DELEPROCTOPHYLLA DUSMETI* (NEUROPTERA, ASCALAPHIDAE)

SINTESI

Tre specie di ascalafidi, Bubopsis agrionoides, Puer maculatus e Deleproctophylla dusmeti *(Ascalaphidae), sono state osservate nell'area mediterranea della Francia.* B. agrionoides e P. maculatus *sono state rinvenute in biotopi caratterizzati dalla presenza di* Quercus ilex, *mentre esemplari di* D. dusmeti *sono stati raccolti in aree aperte con vegetazione bassa. Gli individui di* B. agrionoides e D. dusmeti *si raggruppano e formano popolazioni di importanza variabile, mentre gli individui di* P. maculatus *sono stati osservati sempre solitariamente. Il periodo di attività diurna degli adulti è stato determinato solo per* B. agrionoides e D. dusmeti. *Come le specie del genere* Libelloidess, *le tre specie menzionate nell'articolo sono capaci di utilizzare la parte dorso-frontale UV-sensoria dei loro occhi composti, per percepire la presenza di prede o compagni che volano nel cielo azzurro come sottofondo.*

Parole chiave: ascalafidi, *Deleproctophylla dusmeti*, *Bubopsis agrionoides*, *Puer maculatus*, Francia, ecologia, morfologia oculare

INTRODUCTION

Conversely to the tropical fauna, the systematics of the Ascalaphidae of the Palaearctic region is well known even if the exact status of some species, particularly within the genus *Libelloides* Schäffer, 1763, remains uncertain (Van der Weele, 1908; Aspöck *et al.*, 1980, 2001; Medvedev, 1987). The ten species recorded from the continental part of France belong to the genera *Libelloides* (6 spp), *Deleproctophylla* (1 sp), *Bubopsis* (1 sp) and *Puer* (1 sp) (Aspöck *et al.*, 2001). However, the biology of the species has been poorly investigated and only little information on the adult ecology is available. Recently, some observations made in the South of France on *Bubopsis agrionoides* (Rambur, 1838), *Puer maculatus* (Olivier, 1789) and *Deleproctophylla dusmeti* Navás, 1914 brought some data on the flight period, the frequented biotopes and the behaviour of the adults (Wachmann & Saure, 1997; Mazel, 2001; Morin & Maldés, 2001; Peslier, 2002). The aim of this publication is to present complementary and original information on the biology of these species and to investigate the relationships between the adult ecology and the eye morphology of these three species.

MATERIAL AND METHODS

Studies were carried out in the natural environment of the Montpellier region in Southern France. The morphology of the compound eyes was investigated by magnified images of photographs taken on alive or dried specimens. The colour of the screening pigment in the dorso-frontal and ventral regions of the compound eye was determined by orthodromic illumination of alive specimens with white light using a stereomicroscope and a digital camera.

Tab. 1: Localities of the collected Ascalaphidae in Southern France (coordinates from www.geoportail.fr).
Tab. 1: Lokalitete vrst iz družine Ascalaphidae, odkrite v južni Franciji (koordinate s spleta www.geoportail.fr).

Departements/Localities	longitude (E)	latitude (N)	*B. agrionoides*	*P. maculatus*	*D. dusmeti*
Pyrénées Orientales (66)					
Sahorre	02°21′43″	42°31″57″		X	
Estagel	02°41″57″	42°46″20″		X	
Vinça	02°31′40″	42°38′41″	X		
Sainte Colombe de la Commanderie	02°44′59″	42°36′57″	X		
Vingrau	02°46′52″	42°50′49″	X		
Cases de Pène	02°47′10″	42°46′44′	X		
Espira de l'Agly	02°50′04″	42°46′40″	X		
Banyuls sur Mer	03°07′43″	42°28′52″	X		
Hérault (34)					
Saint Guilhem le Désert	03°32″55″	43°46″46″		X	
Pégairolles de Buèges	03°35′15″	43°48′21″	X		
Argelliers	03°40′14″	43°41′59″	X	X	
Valmalle	03°40′34″	43°36″33″			X
Vailhauquès	03°41″10″	43°40″22″		X	
Le Frouzet	03°41″26″	43°49″01″		X	
Murviel les Montpellier	03°44″13″	43°36″16″			X
Saint Gély du Fesc	03°48″16″	43°41″41″		X	
Causse de l'Hortus	03°49′34″	43°51′06″	X		
Gard (30)					
Region of Nîmes	none	none		X	
Bouches du Rhône (13)					
Plaine de la Crau	04°49′50″	43°31′32″			X
Region of Marseille	none	none		X	
Var (83)					
Hyères	06°07′51″	43°0′45″		X	
Saint Aygulf	06°43′13″	43°23′01″			X

RESULTS

Ecology of the species

Bubopsis agrionoides **(Rambur, 1838)**

B. agrionoides was described by Rambur from a male collected in the South of Spain at the foot of the Sierra-Prieta. Now this species is known from Morocco, Italy and France (Aspöck *et al.*, 2001). In France, *B. agrionoides* was recorded from two departments only, Pyrénées Orientales (Auber & Delamarre Deboutteville, 1955) and Hérault (Schaefer, 1974) (Tab. 1).

The observations were made in the locality of Argelliers at the place named Les Hauts de Boscorre. The station is located on a southern hillside. The soil is composed of calcareous rock with fissures and vertical holes, whose biggest dimension can reach one meter. The substratum is covered by Mediterranean evergreen holm-oak *(Quercus ilex* Linnaeus, 1753). The oak forest is interrupted by area without vegetation, where Mastic tree *(Pistacia lentiscus* Linnaeus, 1753) and annual plants like *Centranthus angustifolius* (Miller, 1805) and *Sedum sediforme* (Jacquin, 1909) (Fig. 1) are flourishing.

Adults fly in July and August. During the journey, several individuals were collected beating the lowest branches of the oaks at the limit of the open rocky areas. When disturbed, the adults fly a short distance before they settle under another tree, where the grey colour of their bodies makes them very difficult to spot when resting on the bark of *Q. ilex*. This behaviour was observed only in a calm weather with light cloudy sky. On windy and sunny days, no adults were found even beating the trees at all their heights. That could mean that the resting sites vary according to the weather conditions. When the conditions are unfavourable, the adults look for a shelter inside the vegetation, where they are very difficult to find. Whatever the weather conditions, no individual was found within the fissures and rocky cavities.

The flight activity was observed in August 2007 on one female. This individual was resting on a twig of *P. lentiscus* at a height of almost two meters (Fig. 2). At 20:30, it began to vibrate its wings for some minutes. This behaviour probably helps to warm the muscles and its duration has to be a function of the temperature. But it has not been possible to observe this behaviour again. Then it flew away and made go-and-come motions above the trees at a height of almost four-five meters. This activity corresponds probably to the behaviour of hunting. It has been possible to observe this female for one hour until 21:30. During this time, no other individual was observed.

On July 14, 2007, a female was collected by light trapping.

Fig. 1: (A) Habitat of *Bubopsis agrionoides* ***at Argelliers consists of small-sized holm-oaks*** *Quercus ilex* ***growing on rocky soil. (B) Aerial picture of the locality with calcareous areas in grey (source www.geoportail.fr).***
Sl. 1: (A) Habitat vrste *Bubopsis agrionoides* ***pri Argelliersu sestoji iz nizkega črničevja*** *Quercus ilex,* ***rastočega v skalovitem območju. (B) Zračni posnetek lokalitete z apnenčastim območjem v sivi barvi (vir www.geoportail.fr).***

Fig. 2: *B. agrionoides* ***female resting on a branch of*** *Pistacia lentiscus* ***at Argelliers before taking flight.***
Sl. 2: Samica vrste *B. agrionoides,* ***počivajoča na mastiki*** *Pistacia lentiscus* ***pri Argelliersu, tik pred poletom z veje.***

***Puer maculatus* (Olivier, 1789)**

This species was described from specimens from Avignon in Southern France (Aspöck & Aspöck, 1987). It is now recorded from Spain, France and Israel (Aspöck *et al.*, 2001).

In spite of its wide distribution (Tab. 1), this species is rarely observed and its ecology remains quite unknown. The recent report from the region of Montpellier by several colleagues *(pers. comm.)* indicates that *P. maculatus* fly in July. In the department of Hérault it was recorded from five localities. Only at Argelliers it was collected in the biotope also frequented by *B. agrionoides*. It was never observed in association with *D. dusmeti* (Tab. 1). Individuals have been collected resting on twigs of grass in the morning and at the end of the afternoon. It seems that it flies above the low vegetation (Fig. 3) and not above trees like *B. agrionoides*. The adults do not fly when it is raining, even when drizzling, and when wind is blowing.

***Deleproctophylla dusmeti* (Navás, 1914)**

This species was described from individuals collected in Spain (Navás, 1914). It is now recorded from Spain and France (Aspöck *et al.,* 2001). In France, it has been recorded from three departments, *i.e.* Hérault, Bouches du Rhône and Var.

The observations were made in the plain of Crau near the village of Saint Martin de Crau and in three places close to Montpellier, Murviel les Montpellier (place named Mas Dieu), Valmalle and on the Causse de l'Hortus, which is a calcareous tableland (Tab. 1).

In all the localities the individuals were observed in Mediterranean grassland covered by low vegetation with only few small trees here and there. At Murviel les Montpellier, the first author also collected *Libelloides ictericus* (Charpentier, 1825) and *Libelloides longicornis* (Linnaeus, 1764) in the same grassland where *D. dusmeti* was collected. Adults flew from mid June to end of July.

In the plain of Crau, the individuals were observed during the morning. The adults began to fly at around 09:30 when the temperature was getting higher. Then they stopped to fly at the end of the morning and rested on grass twigs. Several individuals were flying at the same time. They captured the prey flying, and settled on grass twigs to feed. In the region of Montpellier, the observations were made during the afternoon until sunset. During this period, no flight activity was detected. The individuals were collected after being disturbed by beating the grasses. They flew away, covering quite a long distance, and settled in the grass. The adult activity ceased completely from the sunset onwards. Even beat-

Fig. 3: Habitat of *Puer maculatus* ***at Vailhauquès consists of grass covered area surrounded by*** *Q. ilex* ***formation with rocky areas.***
Sl. 3. Habitat vrste *Puer maculatus* ***pri Vailhauquèsu sestoji iz travnatega območja, ki ga obkrožajo formacije črničevja*** *Q. ilex* ***na skalnatem svetu.***

ing the grass did not permit to observe individuals, which probably rested inside the vegetation. No adults were attracted to light. The colour of this species makes it very difficult to spot the individuals resting on the dry twigs of grass (Fig. 4). This homochromy represents a protective coloration for individuals resting inside the vegetation.

Eye morphology

The compound eyes of living and dried specimens of *B. agrionoides*, *P. maculatus* and *D. dusmeti* were photographed via a stereo optical microscope and the images analyzed. Externally, the eyes exhibit traits typical of the Ascalaphinae (Aspöck *et al.*, 2001; Winterton, 2003). The eyes are divided into a dorso-frontal area and a ventral area, separated by a transverse sulcus. As with other *Libelloides* species studied (Fischer *et al.*, 2006), the division appears particularly prominent. The dorso-frontal region of the eye is distinctly larger than the ventral region. Furthermore, the facet diameters of dorso-frontal ommatidia appear to be larger than those of ventral ommatidia. To a certain extent, the surface of the dorso-frontal region appears somewhat flatter than that of the ventral region, indicating a somewhat greater radius of curvature. This suggests smaller interommatidial angles in these areas, which would mean that greater spatial resolution is to be expected for the dorso-frontal region than for the ventral region. In the closely related *Libelloides macaronius* (Scopoli, 1763), increased visual acuity in the dorso-frontal region due to smaller interommatidial angles has been demonstrated experimentally (for review see Kral, 2002).

Fig. 4: *Deleproctophylla dusmeti* ***female resting on a twig of grass at Murviel Les Montpellier.***
Sl. 4: Samica vrste *Deleproctophylla dusmeti* ***na steblu trave pri kraju Murviel Les Montpellier.***

Orthodromic illumination of the compound eye ommatidia regarding the living specimens of *B. agrionoides* and *D. dusmeti* indicates distinct differences in the spectral reflection properties of the dorso-frontal and ventral parts of the eye. Overall, the former appears yellow, while the latter appears dark (Fig. 5). Depending upon the angle of illumination, this effect can be masked to a greater or lesser extent by the yellowish luminous tracheole system of the ommatidia (luminous pseudopupils, typical of superposition eyes of neuropteran species). However, it indicates yellowish screening pigment in the dorsofrontal and dark screening pigment in the ventral pigment cells that surround the crystalline cone of an ommatidium. In the closely related *L. macaronius*, it has been shown experimentally that the yellowish pigment in the dorso-frontal region of the eye is associated with receptivity to short-wave (violet to UV) light. This provides optimal stimulus conditions for the UV-sensitive retina. In contrast, the dark pigment in the ventral region of the eye permits stimulation of the retina over a broad spectral range (Gogala, 1967; Schneider *et al.*, 1978; Gribakin *et al.*, 1995; Stušek *et al.*, 2000; for review see Kral, 2002).

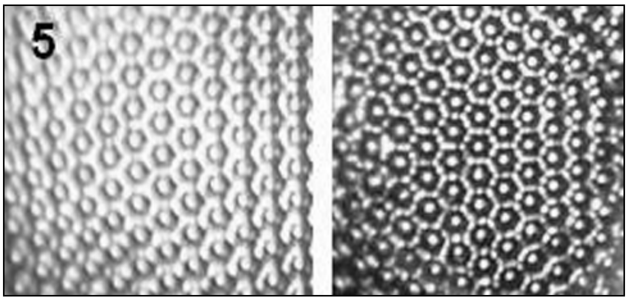


Fig. 5: Ommatidia of compound eye of alive** B. agrionoides **illuminated directly from above with white light showing pseudopupils (light spots) and the yellow screening pigment in the dorso-frontal part and the 'dark' screening pigment in the ventral part (masked by reflecting tracheoles and perhaps by corneal nipples).
Sl. 5: Omatidiji sestavljenega očesa žive metuljčnice** B. agrionoides**, osvetljene naravnost od zgoraj z belo svetlobo; na njej vidimo psevdopupile (svetle lise), rumeni pigment v hrbtno-čelni strani in "temni" pigment v trebušni strani (ki ga zastirajo odsevajoče traheje in morda kornealne bradavice).

DISCUSSION

The observations made in Southern France on three species of Ascalaphidae, *B. agrionoides*, *P. maculatus* and *D. dusmeti* corroborate the information found in the literature (Schaefer, 1974; Rehfeldt, 1989; Wachmann & Saure, 1997; Mazel, 2001; Morin & Maldés, 2001; Peslier, 2002).

However, Mazel (2001) mentioned that *B. agrionoides* can be found also in vegetal formation constituted by Tree Heath *Erica arborea* Linnaeus, 1753 and Hedelyng *Calluna vulgaris* (Linnaeus, 1753) grown on schistose ground. The period of the flight activity of *B. agrionoides* was also observed by Peslier (2002). But this author mentioned that according to the weather conditions, when the sky is cloudy and the light level is low, the adults can begin to fly from 19:30 instead of 20:30. *B. agrionoides* flies at the end of the afternoon until the sunset, but could also be nocturnal, as several captures were made with light trap (Schaefer, 1974; Mazel, 2001; Peslier, 2002).

With regard to *P. maculatus*, the observations reported by Mazel (2001) and Morin & Maldés (2001) indicated that this species can be found in the same biotopes as *B. agrionoides* but conversely to this species it flies lower, above the grass vegetation, and not above trees. *P. maculatus* was also observed at around 700 m above sea level in a locality characterized by a gneiss ground (Mazel, 2001).

Contrary to the precedent species, *D. dusmeti* was found only in open land covered with low vegetation. The same information is reported by Wachmann & Saure (1997) and for *D. australis* by Devetak (1995, 1998). *D. dusmeti* has been observed flying at the end of the morning and resting in the vegetation for the rest of the day.

From the optical and morphological differentiation of the eyes, flight activity can be expected to occur during the daytime in open terrain or above the vegetation, primarily during fine weather (Fischer *et al.*, 2006). This is in fact the case. However, the fact that nocturnal activity is also exhibited by *B. agrionoides* indicates that the eyes can also be utilised with nocturnal lighting conditions. Whether this also applies to the other species, has yet to be investigated. So far, no nocturnal activity has been observed for *Libelloides* species, such as *L. macaronius* and *L. coccajus* (Denis and Schiffermüller, 1775) (Gogala, 1967; for review see Kral, 2002; Fischer *et al.*, 2006; Kral, *unpubl. data)*.

In summary, it is clear that without a detailed histological investigation with the aid of electron microscopy as well as without electrophysiological recordings the questions concerning the vision in *B. agrionoides*, *P. maculatus* and *D. dusmeti* cannot be fully answered. However, whether studies including these techniques will be possible will depend upon the availability of these very rare species.

EKOLOGIJA IN MORFOLOGIJA OČESA PRI VRSTAH *BUBOPSIS AGRIONOIDES*, *PUER MACULATUS* IN *DELEPROCTOPHYLLA DUSMETI* (NEUROPTERA, ASCALAPHIDAE)

Bruno MICHEL

Centre de Coopération Internationale en Recherche Agronomique pour le Développement, TA A-55/L, UMR CBGP, Campus International de Baillarguet, F-34398 Montpellier cedex 5, France

E-mail: bruno.michel@cirad.fr

Karl KRAL

Institute of Zoology, Karl-Franzens-University Graz, A-8010 Graz, Austria

POVZETEK

Avtorja sta v sredozemskem območju Francije preučevala vrste Bubopsis agrionoides, Puer maculatus *in* Deleproctophylla dusmeti *(Ascalaphidae). Vrsti* B. agrionoides *in* P. maculatus *sta zabeležila v biotopih, poraščenih s črničevjem* Quercus ilex*, medtem ko sta vrsto* D. dusmeti *našla v odprti pokrajini, poraščeni z nizko vegetacijo. Osebki* B. agrionoides *in* D. dusmeti *se pregrupirajo, da oblikujejo različno pomembne populacije, osebki vrste* P. maculatus *pa so bili vselej zabeleženi posamično. Čas dnevne aktivnosti je bil ugotovljen le za vrsti* B. agrionoides *in* D. dusmeti*. Vse tri vrste, omenjene v tem prispevku, lahko tako kot vrste iz rodu* Libelloides *uporabljajo za ultravijolične žarke občutljivo hrbtno-čelno stran svojih sestavljenih oči za odkrivanje letečega plena ali partnerjev na ozadju modrega neba.*

Ključne besede: metuljčnice, *Deleproctophylla dusmeti*, *Bubopsis agrionoides*, *Puer maculatus*, Francija, ekologija, morfologija oči

REFERENCES

Aspöck, U. & H. Aspöck (1987): Wiederentdeckung von *Puer maculatus* (Olivier) in Europa (Neuropteroidea: Planipennia: Ascalaphidae). Z. ArbGem. öst. Ent., 39, 5–11.

Aspöck, H., U. Aspöck & H. Hölzel (1980): Die Neuropteren Europas. Eine zusammenfassende Darstellung der Systematik, Ökologie und Chorologie der Neuropteroidea (Megaloptera, Raphidioptera, Planipennia) in Europas. Goecke & Evers, Krefeld, I: 495 p., II: 355 p.

Aspöck, H., H. Hölzel & U. Aspöck (2001): Kommentierter Katalog der Neuropterida (Insecta: Raphidioptera, Megaloptera, Neuroptera) der Westpaläarktis. Denisia, 2, 606 p.

Auber, J. & C. Delamarre Deboutteville (1955): Deux Ascalaphides de la Région de Banyuls.Vie Milieu, 6, 354–358.

Devetak, D. (1995): *Deleprotophylla australis* (Fabricius 1787) in Istria and Quarnero (Neuroptera: Ascalaphidae). Annales, Ser. Hist. Nat., 5(1), 193–198.

Devetak, D. (1998): Neuroptera in different habitats in Istria and Quarnero (NW Balkan). Acta Zool. Fennica, 209, 95–98.

Fischer, K., H. Hölzel & K. Kral (2006): Divided and undivided compound eyes in Ascalaphidae (Insecta, Neuroptera) and their functional and phylogenetic significance. J. Zool. Syst. Evol. Res., 44, 285–289.

Gogala, M. (1967): Die spektrale Empfindlichkeit der Doppelaugen von *Ascalaphus macaronius* SCOP. (Neuroptera: Ascalaphidae). Z. vergl. Physiol., 57, 232–243.

Gribakin, F., E. Alekseyev, S. Shukolyukov & M. Gogala (1995): Unconventional ultraviolet sensitivity spectra of *Ascalaphus* (Insecta, Neuroptera). J. Comp. Physiol., 177, 201–206.

Kral, K. (2002): Ultraviolet vision in European owlflies (Neuroptera: Ascalaphidae): a critical review. Eur. J. Entomol., 99, 1–4.

Mazel, R. (2001): Notes sur les Ascalaphidae du sud de la France (Neuroptera). Rev. Assoc. Roussillonnaise Entomol., 10(1), 3–7.

Medvedev, G. S. (1987): Key to insects of the European part of the USSR. IV, Part 6. Megaloptera, Raphidioptera, Neuroptera, Mecoptera, Trichoptera. Izdaltelstvo "Nauka", Leningradskoe Otdelenie, 200 p.

Morin, D. & J.-M. Maldés (2001): Les lapiaz d'Argelliers: bonne localité héraultaise pour les Ascalaphidae (Neuroptera). Rev. Assoc. Roussillonnaise Entomol., 10(1), 1.

Navás, L. (1914): Acaláfido Nuevo de España. *Deleproctophylla dusmeti* sp. n. Brotéria, Sér. Zool., 12, 57–60.

Olivier, A. G. (1789): Encyclopédie méthodique. Histoire naturelle. Insectes. Vol. 4. (Ascalaphe, *Ascalaphus).* Panckoucke, Paris, pp. 241–246.

Peslier, S. (2002): Observation nouvelles sur le comportement de *Bubopsis agrioides* Rb. (Neuroptera, Ascalaphidae). Rev. Assoc. Roussillonnaise Entomol., 11 (3), 101.

Rambur, M. P. (1838): Faune entomologique de l'Andalousie. Vol. 2. Arthus Bertrand, Paris.

Rehfeldt, G. (1989): Eine Massenwanderung von *Deleproctophylla dusmeti* Navás (Neuroptera: Ascalaphidae) in der Crau (Frankreich). Entomol. Zeitschr., Frankf. a. M., 99, 65–80.

Schaefer, L. (1974): Extrait du procès-verbal de la séance du 5.X.1974. Annales de la Société d'Horticulture et d'Histoire Naturelle de l'Hérault, 114 (4), 144.

Schneider, L., M. Gogala, K. Drašlar, H. Langer & P. Schlecht (1978): Feinstruktur und Schirmpigment-Eigenschaften der Ommatidien des Doppelauges von *Ascalaphus* (Insecta: Neuroptera). Cytobiology, 16, 274–307.

Stušek, P., K. Drašlar, G. Belušič & G. Zupančič (2000): Adaptation mechanisms in insect eyes. Acta Biol. Slov., 43, 41–70.

Van der Weele, H. W. (1908): Ascalaphiden: Monographisch Bearbeitet. Coll. Zool. Selys Longchamps, Fasc. VIII, pp. 1–326.

Wachmann, E. & C. Saure (1997): Netzflügler, Schlamm- und Kamelhalsfliegen: Beobachtung, Lebensweise. Naturbuch Verlag, Augsburg, 159 p.

Winterton, S. L. (2003): Molecular phylogeny of Neuropterida with emphasis on the lacewings (Neuroptera). Entomol. Abh. Staatl. Mus. Tierkunde Dres., 61, 58–160.

Izvirni znanstveni članek
Prejeto: 2008-04-22

UDK 551.311.21(282.2Dragonja)"19"

SPREMEMBE INTENZIVNOSTI EROZIJE V POREČJU DRAGONJE V DRUGI POLOVICI 20. STOLETJA

Miha STAUT
Univerza na Primorskem, Znanstveno-raziskovalno središče Koper, SI-6000 Koper, Garibaldijeva 1, Slovenija
E-mail: miha.staut@zrs-kp.si

Matjaž MIKOŠ
Univerza v Ljubljani, Fakulteta za gradbeništvo in geodezijo, SI-1000 Ljubljana, Hajdrihova ulica 28, Slovenija

IZVLEČEK

Prispevek obravnava procese erozije prsti v porečju Dragonje in spreminjanje njihove intenzivnosti iz preteklosti v sedanjost. Za ocenjevanje intenzivnosti erozijskih procesov posameznega časovnega preseka je bila uporabljena Gavrilovićeva metoda. Njena splošnost omogoča oceno količine sproščene in odplavljene preperelinе tudi iz posrednih virov, kot so na primer letalski posnetki. Časovni obseg je zatorej posegel v obdobje, iz katerega so na voljo omenjeni posnetki, to je obdobje druge polovice 20. stoletja. Izdelane so bile ocene sproščanja gradiva in kvantitativna primerjava obsega erozijskih žarišč in njihove lege v pokrajini za leti 1955 in 2003. Na koncu smo ugotovljeni trend upadanja intenzivnosti erozijskih procesov skušali vzporejati s socioekonomskimi spremembami tega prostora v obravnavanem obdobju. V teku omenjenega obdobja smo ugotovili trend upadanja erozijske aktivnosti. Nelinearnost tega procesa gre verjetno pripisati različnim virom zajema podatkov za posamezna obdobja analize, pri čemer gre levji delež pripisati razlikam v zelo vplivnem koeficientu erozijske izraženosti Xa. *V splošnem lahko trdimo, da so erozijski procesi najbolj intenzivni v zgornjem delu porečja in na pritokih spodnjega dela porečja. Med letoma 1955 in 2003 se je površina erozijskih žarišč zmanjšala z 2,74 km^2 na 0,36 km^2 oziroma 7,6-krat. Ekspozicije erozijskih žarišč se glede na strani neba spreminjajo izrazito zvezno z viškom na pobočjih, ki gledajo na jugovzhod in vzhod, in nižkom na pobočjih, ki gledajo na zahod.*

Ključne besede: Dragonja, geomorfologija, erozija, raba tal, letalski posnetki

VARIAZIONI NELL'INTENSITÀ DI EROSIONE DEL BACINO IDROGRAFICO DEL FIUME DRAGOGNA NELLA SECONDA METÀ DEL VENTESIMO SECOLO

SINTESI

L'articolo tratta i processi di erosione del suolo del bacino idrografico del fiume Dragogna e la sua evoluzione. Per la valutazione dell'intensità dei processi di erosione è stato usato il metodo Gavrilović, che permette di stimare la quantità di materiale distaccato e dilavato anche usando fonti indirette, quali le fotografie aeree. I dati disponibili per l'analisi rientrano nell'intervallo di tempo che comprende la seconda metà del ventesimo secolo. I risultati indicano che durante il periodo analizzato si è verificata una diminuizione nell'intensità dei processi di erosione. La non-linearità di tale tendenza è dovuta probabilmente a differenti fonti di dati per differenti intervalli temporali. I processi erosivi sono in generale più intensi nei tratti superiori del bacino idrico e negli affluenti della parte inferiore del fiume Dragogna. Fra gli anni dal 1955 al 2003, la superficie dei calanchi si è ridotta da 2,74 km^2 a 0,36 km^2, il che significa una dimunuizione pari a 7,6 volte. I calanchi sono in continuo mutamento, e raggiungono la loro massima esposizione su pendii rivolti a sud-est ed est, mentre la minima su pendii rivolti a ovest.

Parole chiave: fiume Dragogna, geomorfologia, erosione, uso del suolo, fotografia aerea

UVOD

Vodna in vetrna erozija sta običajna procesa preoblikovanja pokrajin na vseh celinah. Vendar se ponekod javljata pogosteje in z večjo intenziteto kot drugod. Erozija prsti je postala problem, ko je človek začel površje kmetijsko izkoriščati. Čeprav danes v razvitem svetu ni več tako žgoče vprašanje, kot je bilo recimo v tridesetih letih prejšnjega stoletja (v času "dust bowla"), problem kljub temu ostaja tako v razvitih, še bolj pa v državah v razvoju, ki so močneje vezane na kmetijsko proizvodnjo. Intenzivne padavine v hladni polovici leta, pogosto v obliki neviht in ploh, močni vetrovi, dolgotrajne visoke poletne temperature, ki so vzrok za mirovanje rastlinstva, dolgotrajna in intenzivna raba površja za kmetijstvo itd. so nekateri od dejavnikov, ki prispevajo k jakosti erozije v sredozemskem svetu. Zaradi tega se je to območje v literaturi uveljavilo kot eno klasičnih območij preučevanja tega kompleksnega pojava, še posebej v navezavi z dolgotrajno in intenzivno kmetijsko rabo, ki je za ta del sveta značilna (Morgan, 1979). Tudi istrska pokrajina, kot del tega sveta, je neprekinjeno naseljena in izkoriščana že od predantike (Darovec, 1992), zato se antropogeni učinki na erozijo prsti, tako kot v preostalem Sredozemlju, verjetno pojavljajo že zelo dolgo.

Namen prispevka je opredelitev razvoja in spreminjanja intenzivnosti erozijskih procesov iz preteklosti v sedanjost. Pri tem je v središču zanimanja predvsem spreminjanje hitrosti sproščanja preperelina in odnos oziroma vpliv, ki ga ima človeška družba na fenomen pospešene erozije. V delu smo skušali med drugim ugotoviti, ali je erozija opazen proces v pokrajini in ali se zrcali tudi v delovanju človeške družbe. Za dosego tega namena je treba:

- opredeliti količino sproščene prepereline in njeno časovno spreminjanje;
- poiskati vzroke za take spremembe;
- v okviru tega še posebej izločiti vpliv, ki ga ima človeška družba na erozijo.

Gavrilovićeva metoda, ki obsega osrednji del metodološkega aparata prispevka, izhaja iz gozdarstva (hudourništva) in je doslej doživela široko uporabo na slovenskih porečjih. Na Dragonji je bila Gavrilovićeva metoda uporabljena dvakrat, obakrat v izvirni obliki. Prvič leta 1971 v okviru Podjetja za urejanje hudournikov (Paulič, 1971). Na podlagi te raziskave so v porečju opravili hidroregulacijska dela z namenom preprečevanja pospešene erozije. Drugič je metodo uporabila Globevnik in na podlagi primerjave z letom 1971 skušala ocenjevati razvoj intenzivnosti erozijskih procesov (Globevnik, 2001). Gavrilovićevo metodo so uporabili tudi na hrvaškem delu reke Dragonje (Vodoprivreda, 1987). Globevnik (2001) je skušala v okviru doktorskega dela oceniti spremembe v režimu reke Dragonje in razvoj erozijskih procesov ter kako nanje vplivajo naravne in družbene spremembe v porečju. Petkovšek (2002) je skušal natančneje oceniti faktor erozivnosti *R*, ki se vključuje v enačbo RUSLE (Revised universal soil loss equation) in je kasneje na podlagi te enačbe podal oceno sproščanja in odplavljanja v porečju Dragonje. Šraj (2003) se je v svojem doktorskem delu osredotočila na ocenjevanje deleža padavin, ki jo različne rastlinske združbe zadržijo. Nedavno tega je bila izdelana doktorska disertacija s področja erozije v porečju Dragonje tudi v geografskih vrstah. Zorn je ocenil dinamiko različnih geomorfnih procesov, ki potekajo na rečno-denudacijskem reliefu tega porečja (Zorn, 2007).

METODE

Osrednji del metodološkega aparata je Gavrilovićeva metoda (Gavrilović, 1970). Prednosti metode so, da je lahko umljiva in da je njena aplikacija enostavna, slabost pa je, da se končni kvantitativni rezultat jakosti erozije izračuna tudi iz kvalitativnih ocen parametrov, zastopanih v enačbi. Zato se uvršča v skupino *empirično parametričnih modelov*. Če je analizirano površje (porečje ali erozijsko območje) preveč morfološko pestro, da bi ga lahko obravnavali kot enoto, ga lahko izboljšamo z analizo po podenotah in ga tako naredimo *distribuiranega*.

Erozijski koeficient *Z* je mera, s katero ocenjujemo intenzivnost oziroma gostoto erozijskih procesov. Večletni poskusi različnih avtorjev, ki jih je Gavrilović sintetiziral, so pripeljali do naslednje empirične enačbe, s katero ocenjujemo stopnjo erozijskega koeficienta *Z*:

$$Z = Y \cdot Xa \cdot \left(\varphi + \sqrt{J}\right)$$

Y je koeficient erodibilnosti. *X* in *a* se obravnavata skupaj in predstavljata koeficient rabe tal (vegetacijski koeficient), *X* kot posledica naravnih razmer ter *a* kot koeficient zaščitnih ukrepov, ocenjen na podlagi obsega protierozijskih del, opravljenih v porečju. Koeficient φ predstavlja številsko oceno izraženosti erozijskih procesov, *J* pa srednji naklon območja, izražen v metrih oziroma procentih (Gavrilović, 1970).

Koeficient erodibilnosti lahko opišemo tudi kot obratno vrednost odpornosti prsti na spiranje zaradi energijskega vnosa dežnih kapljic. Ponavadi je določen eksperimentalno v laboratoriju ali na terenu, na osnovi teh rezultatov pa so podane tabele standardnih vrednosti (Tab. 1).

Parametra *Xa* in φ sta bila za porečje Dragonje pridobljena z metodo fotointerpretacije aeroposnetkov, le skrajni južni del (južni del porečja levega pritoka Argila) je bil zaradi dejstva, da nimamo aeroposnetkov za leto 2003, kartiran na terenu. Uporabljeni so bili posnetki iz treh obdobij, ki približno ustrezajo obdobjem interesa in predhodnih raziskav. Ta obdobja so leto 1954 skupaj z letom 1957 (slednje za jugozahodni del porečja), leto 1975, ki se raziskavi, opravljeni leta 1971, še najbolj približuje, in leto 2003, ki naj bi ponazarjalo današnje stanje.

Tab. 1: Vrednosti koeficienta** Y **(vir: Gavrilović, 1970).
Tab. 1: The values of the coefficient** Y **(source: Gavrilović, 1970).

Litološke in pedološke značilnosti matične podlage	*Y*
peski, prodi in nevezani sedimenti	1,00
puhlice, tufi in stepske prsti	0,80
prepereli karbonati in laporji	0,60
peščenjaki, bazične magmatske kamnine in fliš	0,55
podzoli, skrilavci in različni tipi gnajsov	0,50
neprepereli karbonati, rdeče prsti in humusno-silikatne prsti	0,45
gorske prsti	0,40
psevdooglejene in oglejene prsti	0,30
črne prsti in rečne naplavine dobre strukture	0,25
nepreperele predornine	0,12

Koeficienta rabe tal *X* in zaščitenosti površja *a* ponazarjata številsko oceno zaščitenosti območja pred atmosferskimi vplivi in erozijo. Koeficient *X* je odvisen od zemljiške kategorije, značilnosti rastlinske združbe in stopnje pokritosti, koeficient *a* pa od ukrepov, usmerjenih v manjšanje erozijske aktivnosti (predvsem v kmetijstvu). V bistvu se koeficienta obravnavata skupaj, njuna vrednost pa se lahko giblje med 0,01 za popolnoma zaščiteno površje in 1 za popolnoma golo in nezaščiteno površje. Interpretacijski ključ se je kljub nekaterim pomanjkljivostim poskušal nasloniti na kategorije, ki so določene v izvirni Gavrilovićevi shemi. Nekatere kategorije so bile zaradi podobnosti združene v eno, nekatere izpuščene in nekatere preurejene.

V kategorijo *povsem golo površje* so bile uvrščene površine erozijskih žarišč, obsežnejša prodišča v strugah vodotokov in območja, razgaljena zaradi gradbenih del. To so površine, kjer je pomanjkanje vegetacije popolno ali skoraj popolno. Na črno-belih posnetkih so se kljub flišni podlagi jasno ločile od preostalega območja po zelo svetlih površinah, ki so bile v izrazitem kontrastu z okolico. Na barvnih posnetkih so bila tako prodišča kot erozijska žarišča sive barve. Območja, kjer so procesi manj aktivni ali so prekrita s tanko preperelino, pa so bili na posnetkih videti bolj rjave barve. Barvno razlikovanje je možno tudi zaradi razlik med peščenjaki in muljevci. Tudi s tega vidika obstaja določena stopnja povezanosti, saj so muljevci manj odporni in manj prepustni za vodo, zato so erozijski procesi na njih intenzivnejši. *Xa* = 1.

Na črno-belih posnetkih smeri oranja največkrat ni bilo videti. Še posebno to velja za posnetke iz let 1954 in 1957, ki imajo manjšo natančnost. Zato so bile v kategorijo *njive z oranjem v smeri naklona* štete njivske površine v dnu dolin in na površinah tako rekoč brez naklona. V Slovenski Istri skorajda ni njiv, ki jih ne bi orali prečno na smer naklona. Njive se od preostalih površin ločijo po hrapavi teksturi in pravokotni obliki. *Xa* = 0,9.

Sadovnjaki in vinogradi brez zeliščne vegetacije so površine, ki niso terasirane in so redno orane. Tudi ta kategorija je skoraj izključno v dnu dolin, saj klasifikacija loči tudi sadovnjake in vinograde v smeri plastnic. Na slikah jih prepoznamo po urejenosti v vrste, sadovnjake pa po pikčastem vzorcu okroglih krošenj. Možna je predvsem zamenjava mladih oljčnikov z njivami, ker drobnih stebelc in njihovih senc ne vidimo. Sadovnjake s starim drevjem je možno zamenjati z gozdom. Sadovnjakov in vinogradov z zeliščno vegetacijo v Gavrilovićevi klasifikaciji ni. Na osnovi domneve o večji odpornosti na erozijske procese smo te površine prišteli med sadovnjake in vinograde v smeri plastnic. *Xa* = 0,7.

V kategorijo *travinje* so bile vštete vse travne površine, torej tako travniki kot pašniki pa tudi zatravljene zaraščajoče se površine, ki niso v uporabi. Ta kategorija se na črno-belih posnetkih ločuje od drugih po homogeni svetlejši sivi barvi. *Xa* = 0,4.

Klasifikacija na tem mestu loči degradirane gozdove in gozdove z erodiranimi tlemi. V porečju Dragonje kot tudi širše v Slovenski Istri so v pokrajini mnogo bolj markantna poteza grmišča in mladi gozdovi. To kategorijo karakterizirata predvsem grmiščna vegetacija in mlad gozd, ki se uveljavljata na nekdanjih obdelovalnih površinah. Tudi za nekatere združbe gozdov v Slovenski Istri je značilen travni sloj (predvsem gozdovi hrasta puhavca *(Quercus pubescens)* in gradna *(Quercus petraea)* z jesensko vilovino *(Sesleria autumnalis))*. Na letalskih posnetkih jih je moč ločiti po svetlejši barvi goste travne vegetacije, ki še obstaja v sencah grmičja in mladih drevesc. Zaradi neizrazitosti degradiranih gozdov in izrazitih površin v zaraščanju v obeh letih obravnave sta se avtorja odločila za zamenjavo kategorije degradirani gozdovi in grmišča z erodiranimi tlemi s kategorijo *grmišča in mladi gozdovi* in ji prirediti vrednost koeficienta *Xa* = 0,0375. Vrednost je bila določena na podlagi članka S. Keesstre in O. van Dama (Keesstra, 2007), ki sta za isto območje izdelala podobno raziskavo, le da sta za oceno količine odplavljanja uporabila metodo RUSLE. Med kategorijami rabe tal oziroma faktorja *C* sta upoštevala tudi mladi gozd (*C* = 0,003) in gozd (*C* = 0,004). Potrebna je bila le še uskladitev v vrednostmi Gavrilovićevega koeficienta Xa_{gmg} = 0,05 0,003 / 0,004 = 0,0375.

Preostali del gozdov je bil uvrščen med *gozdove dobre sestave in zarasti*. Ti so na posnetkih temno sive oziroma temno zelene barve z dobro vidnimi, gostimi krošnjami. *Xa* = 0,05.

Njive v smeri plastnic so tiste, ki ležijo na pobočju, imajo razgaljeno rušo in niso na terasah. Možna je zamenjava z mladimi oljčniki oziroma na ortofotu-načrtu iz leta 2003 s terasiranimi površinami. *Xa* = 0,63.

Podoben kot je odnos med njivami z oranjem v

smeri naklona in njivami v smeri plastnic, je tudi odnos med sadovnjaki in vinogradi brez zeliščne vegetacije in *sadovnjaki in vinogradi v smeri plastnic*. *Xa* = 0,315.

Med terasirane površine je bilo všteto vse, kar je na terasah, ne glede na prevladujočo zemljiško kategorijo, izvzemši terase, na katerih prevladuje gozd. Vir možnih napak je predvsem ortofoto-načrt, na katerem je brez posrednih znakov relief neviden. *Xa* = 0,36.

Zaradi tako široke zasnovanosti kategorije terasirane površine je bila terasam dodana dodatna kategorija *pogozdene ali ogozdene terase*. Mednje so štete terase, na katerih se razrašča gozd. To so večinoma terase na pobočjih z izrazito severno ekspozicijo, ki so bile po največjem razmahu obdelovalnih površin v drugi polovici 19. stoletja opuščene najprej. Na njih je danes enak gozd kot v gozdovih dobre sestave in zarasti. Na nekdanje terasiranje opozarja le stopničastost, ki je opazna na krošnjah. Možna je zamenjava z gozdom dobre sestave in zarasti, saj so krošnje slab kazalec mikrooblikovanosti površja pod njimi. Zamenjava ni tako huda napaka, ker imata obe kategoriji enaki vrednosti *Xa* = 0,05.

Osnovni razpredelnici je bila dodana kategorija *pozidane površine Xa* = 0,1. Te ponazarjajo le naselja, torej območja zgoščene pozidave, ne pa tudi prometnic. Prometnice so bile iz členitve izpuščene, ker so lahko glede vrednosti koeficienta, ki bi jim ga pripisali, zavajajoče. Za asfaltirane površine lahko trdimo, da erozije praktično ni, zato bi koeficientu *Xa* pripisali vrednost 0. Večkrat te površine rabijo za koncentracijo vode (infiltracija v asfalt je 0), ki je speljana v obcestni kanal. Erozija se v takem kanalu, če ni obzidan, lahko močno pospeši. Kolovozi in vlake so zaradi svoje razgaljenosti in kolesnic, ki lovijo in usmerjajo vodo, ravno tako potencialni vir erozije, pod pogojem, da je naklon na njih dovolj velik. To se nazorno kaže na kolovozu, ki iz Trseka vodi južno proti dolini Dragonje.

Napak pri identifikaciji tipov rabe tal in koeficienta erozijske izraženosti je nekaj vrst. Lahko so nastale zaradi uporabe po natančnosti, mediju in barvni globini različnih aeroposnetkov. Raba tal za leto 1954 skupaj z letom 1957 je bila zajeta s pomočjo identifikacije kategorij iz stereoskopskih parov in prerisovanja na karto merila 1 : 25.000. Napake pri tem pristopu lahko izvirajo iz slabšega prepoznavanja kategorij in generalizacije pri prenašanju identificiranega na karto. Raba tal v letu 2003 pa je bila zajeta s pomočjo digitalnih barvnih ortofoto-načrtov. Napake pri tem pristopu lahko izvirajo iz uničenja paralakse v procesu pretvorbe aeroposnetkov v ortofoto-načrt. Zaradi tega so terase vidne le zaradi senc, ki jih mečejo, ali pa lahko nanje sklepamo zaradi ozkosti parcel, ki jih določa oblika terase. Če ni ne enega ne drugega, je ločevanje teras brez dodatnih informacij zelo težavno. Karti koeficientov *Xa* za obdobji 1954/57 in 2003 sta bili med seboj le delno usklajeni. Zajem podatkov za obe obdobji je potekal neodvisno drug od drugega, nato pa je prišlo na že izdelanih kartah do delnega usklajevanja obeh. Zato je na nekaterih mestih možna tudi kakšna nelogična kombinacija. Karta rabe tal za leto 2003 je bila preverjena na terenu na dveh kontrolnih mestih: v porečju Argile v okolici Merišča in v povirnih delih Stranice.

Koeficient φ ponazarja stopnjo izraženosti erozijskih procesov v porečju ali erozijskem območju. Vrednosti tega koeficienta se gibljejo med 0,1 in 1 (Tab. 2).

Ocenjevanje erozijskega koeficienta φ je težavno, ker načeloma sloni na ekspertni oceni nekoga, ki metodo pozna in ima dovolj znanja, da je sposoben oceniti stopnjo izraženosti erozijskih procesov na podlagi videnega. Zaradi tega sta se avtorja pri oceni tega koeficienta kot tudi pri delitvi na podporečja in delitvi tipov erozijskih žarišč na *erozijska žarišča površinske erozije* in *erozijska žarišča globinske in bočne erozije* naslonila na raziskavo, ki jo je opravil PUH (Paulič, 1971) po kateri je povzela tudi Globevnik (2001). V njej delijo erozijska žarišča še na ožja in širša. Prva so tista, kjer prehaja površinska erozija v globinsko, druga pa zahtevajo vegetacijsko ureditev površin (Pintar & Mikoš, 1983).

Tab. 2: Značilne vrednosti koeficienta φ (vir: Gavrilović, 1970).
Tab. 2: Typical values of the coefficient φ (source: Gavrilović, 1970).

Dejavniki, ki vplivajo na vrednost koeficienta φ	φ
Območje je povsem golo z izraženo jarkovno in žlebično erozijo. Prevladuje globinska erozija.	1,00
Na okrog 80% porečja prevladuje jarkovna in žlebična erozija.	0,90
Na okrog 50% porečja prevladuje jarkovna in žlebična erozija.	0,80
V celem porečju je razvita površinska erozija. Nekaj je žlebičenja in jarkov. Tudi močna kraška erozija.	0,70
V celem porečju je razvita površinska erozija. Brez žlebičenja in jarkov.	0,60
Na polovici porečja je razvita površinska erozija, preostali del pa je ohranjen.	0,50
Na 20% porečja je razvita površinska erozija, preostali del pa je ohranjen.	0,30
V porečju ni vidnih sledov erozije. Na bregovih vodotokov so manjši usadi in zdrsi.	0,20
Porečje brez vidnih sledov erozije. Prevladujejo ornice.	0,15
Porečje je brez vidnih sledov erozije. Prevladuje gozd, deloma tudi travniki in pašniki.	0,10

Zadnji izmed dejavnikov, ki se vključuje v enačbo intenzitete erozije *Z*, je povprečni naklon v porečju ali erozijskem območju *J* in se izraža v metrih (Gavrilović, 1970) oziroma odstotkih (Paulič, 1971).

Razen z Gavrilovićevo metodo sta avtorja časovni razvoj v okviru mogočega ocenila s pomočjo primerjave obsega erozijskih žarišč med leti 1954/57 in 2003. Pri tem obstaja možnost večine zgoraj omenjenih napak.

Neobhoden rezultat vsake metode, ki se ukvarja z vodno erozijo, je tudi poskus ocene količine sproščenega in odplavljenega gradiva. Gavrilović (1970) je na podoben način kot zgornjo enačbo izpeljal tudi to:

$$W_l = \sqrt{\frac{t^0 + 1}{10}} \cdot H_l \cdot \pi \cdot \sqrt{Z^3} \cdot F \, ,$$

kjer je W_l povprečna letna produkcija sproščene prepereline v $m^3 leto^{-1}$, t^0 je povprečna letna temperatura zraka območja v ˚C, H_l ponazarja povprečno letno višino padavin v mm, *F* je površina porečja v km^2 in *Z* zgoraj pojasnjeni erozijski koeficient.

Pri odločanju med uporabnostjo in natančnostjo modela se je Gavrilović verjetno raje odločal za prvo. To je razvidno iz uporabe enostavnih in lahko umljivih parametrov, ki jih ni težko pridobiti, ter prednostne uporabe povprečnih vrednosti (padavine in temperature) pred ekstremnimi. Enačbe, ki privedejo do izračuna količinske ocene sproščene prepereline, pa so naravnane na zmerne in humidne podnebne tipe.

Ker je bila Gavrilovićeva metoda za izračun intenzivnosti erozije v porečju Dragonje uporabljena že dvakrat (Paulič, 1971; Globevnik, 2001) in ker je mogoče parametre, ki se vključujejo v enačbo, kljub njihovim pomanjkljivostim oceniti tudi posredno, se je izbrana metoda za pričujočo raziskavo izkazala kot daleč najprimernejša.

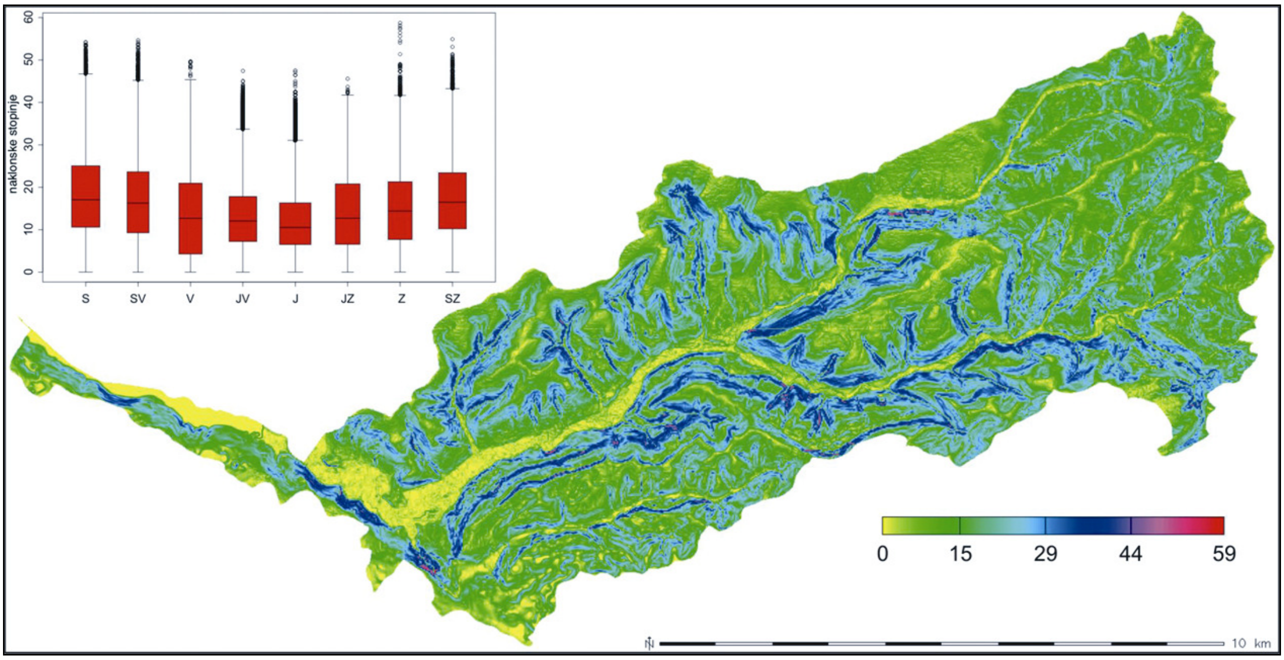
Opis porečja s parametri Gavrilovičeve metode

Dragonja je ena redkih slovenskih rek z neposrednim izlivom v morje. Njeno porečje leži na južnem delu Slovenske Istre, okrog četrtina pa tudi na hrvaškem ozemlju. Danes porečje obmejne Dragonje obsega okrog 94 km^2 površja. Glede na povprečni naklon v porečju, ki znaša *J* = 14,85˚ = 25,62%, in povprečno višinsko razliko v kvadratnem kilometru bi lahko večino porečja uvrstili med gričevja, akumulacijsko ravnico ob spodnji Dragonji med ravnine, nekatere dele ob zgornjem toku Dragonje pa med hribovja (Perko, 1994).

Razporeditev površja po posameznih ekspozicijah je na sliki 1 prikazana s širino škatlastega grafikona, nakloni pa so v stopinjah opredeljeni na ordinatni osi. Najbolj zastopan je prav razred z najmanjšimi nakloni. Severne ekspozicije so zastopane nadpovprečno, predvsem zaradi poteka glavnih slemen v smeri sever-jug, verjetno pa tudi zaradi spodnjega dela porečja, kjer je porečje proti severu "odprto", na jugu pa se zaključuje z ravnikom Bujskega krasa. Jasno je razvidno, da so severne ekspozicije strmejše od južnih. Strmejše severne ekspozicije pa niso značilnost zgolj porečja Dragonje. Človek bi lahko hitro pomislil, da je za večjo strmino severnih ekspozicij krivo predvsem pobočje Bujskega krasa. Strma pobočja s severno ekspozicijo se pojavljajo povsod v flišni Slovenski Istri, kjer večina glavnih slemen poteka v smeri vzhod-zahod. Od tod tudi prevlada južnih in severnih ekspozicij nad vzhodnimi in zahodnimi (Sl. 1). Takšna razporeditev naklonov verjetno ni posledica vpada skladov, saj so skladi v zahodnem delu porečja večinoma vodoravni, v vzhodnem delu pa so bolj nagubani. Edino pobočje, ki je jasno vezano na strukturo, je stik Bujskega krasa z dolino spodnjega toka Dragonje. To je skladno, a je poleg ozko vrezanih grap v flišu najstrmejše v porečju (Sl. 1).

Koeficient erodibilnosti nam skuša na številčni osnovi opisati značilnosti podlage z vidika njene izpostavljenosti eroziji. Nanj vplivajo značilnosti geološke podlage in značilnosti prsti. Pri geološki podlagi sta pomembni petrografska in mineralna sestava, saj predvsem ti dve določata dovzetnost za različne oblike preperevanja in odnašanja, vplivata pa tudi na značilnosti prsti, ki nastanejo iz posameznega substrata. Večina lastnosti prsti vpliva na izpostavljenost k njenemu odnašanju. Te naj bi obsegale teksturo, strukturno stabilnost, delež organskih snovi, vrsto glinenih mineralov in druge kemične lastnosti prsti (Lal, 1994). Mikoš deli lastnosti prsti v tri sklope: na osnovne (poroznost, gostota, prepustnost, vodosprejemnost, vodozadrževalnost), posledične (povezanost, lepljivost, vlažnost) in odvisne (stabilnost, nosilnost, obstojnost, obdelovalnost, rodovitnost in uporabnost) (Pintar & Mikoš, 1983; Mikoš, 1995). Litološko lahko obravnavano ozemlje delimo v grobem na tri dele (Sl. 2). Površinsko močno prevladuje **območje klastičnih kamnin** (83 km^2 oziroma 87,4%), ki so granulacijsko precej raznolike.

Avtomorfne prsti, razvite na podlagi iz klastičnih kamnin, sežejo od surovih prsti (regosol) do evtričnih rjavih prsti. *Surove prsti* se pojavljajo na najstrmejših pobočjih, kjer je odnašanje zelo močno. Zaradi mehke flišne podlage se tvorijo dokaj hitro in imajo majhen delež skeleta. V pedosekvenci surovi prsti sledi *karbonatna rendzina na flišu*. Po pedološki karti obsega ta tip prsti največje površine. Večinoma se pojavlja na strmih pobočjih. Ta prst je že dovolj rodovitna, da so jo ponekod tudi kmetijsko izkoriščali (Lovrenčak, 1994). Tako je nastala *antropogena rendzina na flišu*. Kjer se naklon pobočij zniža toliko, da omogoča razvoj debelejših prsti oziroma to omogoča zaščitni sloj rastlinstva, in kjer človek v prst ni posegal pretirano, najdemo *evtrične rjave prsti na flišu*. Če je površje toliko uravnano, da je zaradi tega oteženo odtekanje vode, se v rjavih prsteh pojavijo znaki *psevdooglejevanja*. Najdemo jih v višjih delih dnov dolin in na širokih slemenih, ki so za Slovensko Istro tako značilna. Kjer se je uveljavilo globoko



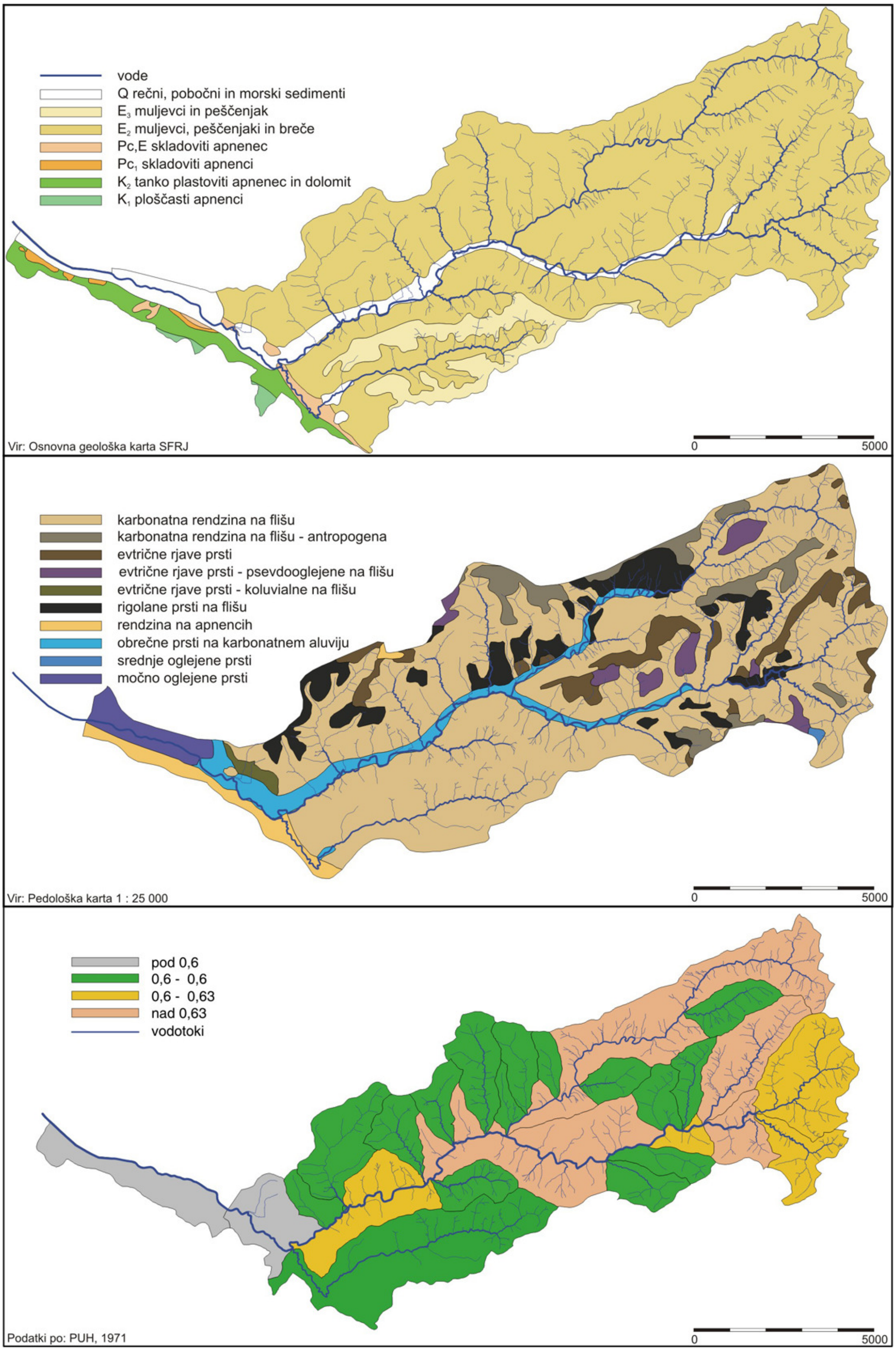
Sl. 1: Nakloni površja v porečju Dragonje in porazdelitev naklonov po ekspozicijah (podatki: DMR-25, GURS).
Fig. 1: Slopes in the catchment of the Dragonja river and the distribution of slopes by expositions (data: DMR-25, GURS).

oranje, se je sestava uničila in prevladuje enotni horizont P. Tem prstem pravimo *rigolane prsti na flišu*. Večina jih je na terasah, ki so danes v precejšnji meri že opuščene (Globevnik, 2001).

Jugozahodni rob porečja se že vzpenja na rob Bujskega krasa. To je **območje dobro zakraselih apnencev**. Ti obsegajo 5 km^2 oziroma nekaj več kot 5% porečja Dragonje. Razen redkih grap, ki se spuščajo po strmem pobočju nad spodnjo dolino Dragonje, rečna mreža tu ni razvita. Poleg Bujskega krasa sta apneniški še dve okni, ki ju je Dragonja s svojim vrezovanjem ločila od ravnika, zasipavanje Dragonje pa ju še ni prekrilo. Na Bujskem krasu najdemo prsti, značilne za kraške pokrajine. To so predvsem *plitve rendzine*. Kjer se površje uravna, v ulekninah in v dneh vrtač, najdemo tudi nekaj *jerovice*, ki je rdeča in je za apneniški del Istre tako značilna, da je po njej dobil ime (rdeča Istra). Prst je zaradi plitkosti sušna in dobro prepustna za vodo. Debelina omenjenih prsti je zelo raznolika in lahko v ulekninah in kraških žepih doseže več metrov.

Tretji del porečja Dragonje tvorijo **nesprijeti sedimenti v dnu dolin**, ki obsegajo 7 km^2 ali 7,3%. Največje območje predstavlja spodnja dolina Dragonje. Ti sedimenti so predvsem rečnega izvora, v spodnjem delu doline pa se delno mešajo z morskimi (Osnovna geološka karta SFRJ, 1973). Manjša območja rečnih sedimentov najdemo tudi više v širših delih dolin, kjer strmec rekam naglo pade. Pobočnih sedimentov je malo, saj fliš hitro razpada v finejše gradivo, ki ga je voda sposobna bolje odnašati, zato v podnožjih pobočij le redko zastaja v večjem obsegu. Ti sedimenti imajo daleč najvišjo erodibilnost med vsemi tremi omenjenimi območji. Če so že prestali erozivni transport, večinoma ležijo na mestih z majhnimi nakloni. Na tej podlagi so se razvili trije tipi prsti. Prvi tip so *obrečne prsti na karbonatnih naplavinah*. Te prsti najdemo na mladih rečnih nanosih ob vodotokih v srednjih delih dolin. Razlikujemo dva podtipa. V *srednje oglejenih prsteh* voda zastaja v globini od 30 do 100 cm. Najdemo jih v spodjem delu doline Dragonje in na planotasto uravnanem svetu okrog Sirčev, ki se že preveša v sosednje porečje Malinske. V najnižjih delih akumulacijske ravnice ob spodnji Dragonji najdemo *težke oglejene prsti*, pri katerih se talna voda zadržuje v globini od 5 do 70 cm. Te prsti so posledično glinaste in mastne, zaradi redukcijskih razmer pa temne do modrikaste barve. Glede na prej omenjeno členitev na podporečja, ki so osnovne celice naše analize, lahko priredimo koeficiente erodibilnosti, kot so razvidni iz slike 2.

V porečju Dragonje stalnih padavinskih ali klimatskih postaj monitoringa Agencije Republike Slovenije za okolje ni. V Koštaboni so potekala merjenja med letoma 1963 in 1994, na klimatološki postaji Dragonja pa med letoma 1961 in 1987. Na območju nekdanjega porečja Dragonje je klimatološka postaja Portorož. Povprečne letna količina padavin se v Slovenski Istri zvišuje od morja proti notranjosti, od okrog 1000 mm do več kot 1600 mm (Zupančič, 1998). Padavine se od morja proti

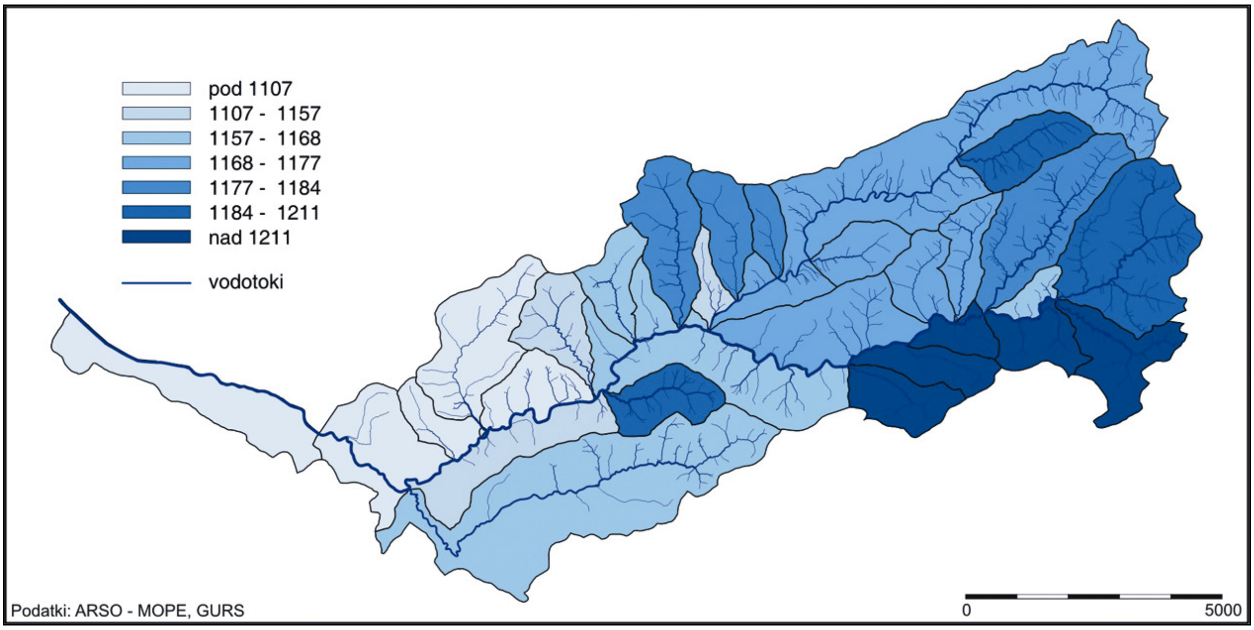


Sl. 2: Litološka karta, pedološka karta in karta koeficienta erodibilnosti *Y*.
Fig. 2: Lithological and pedological map and the map of the coefficient of erodibility *Y*.

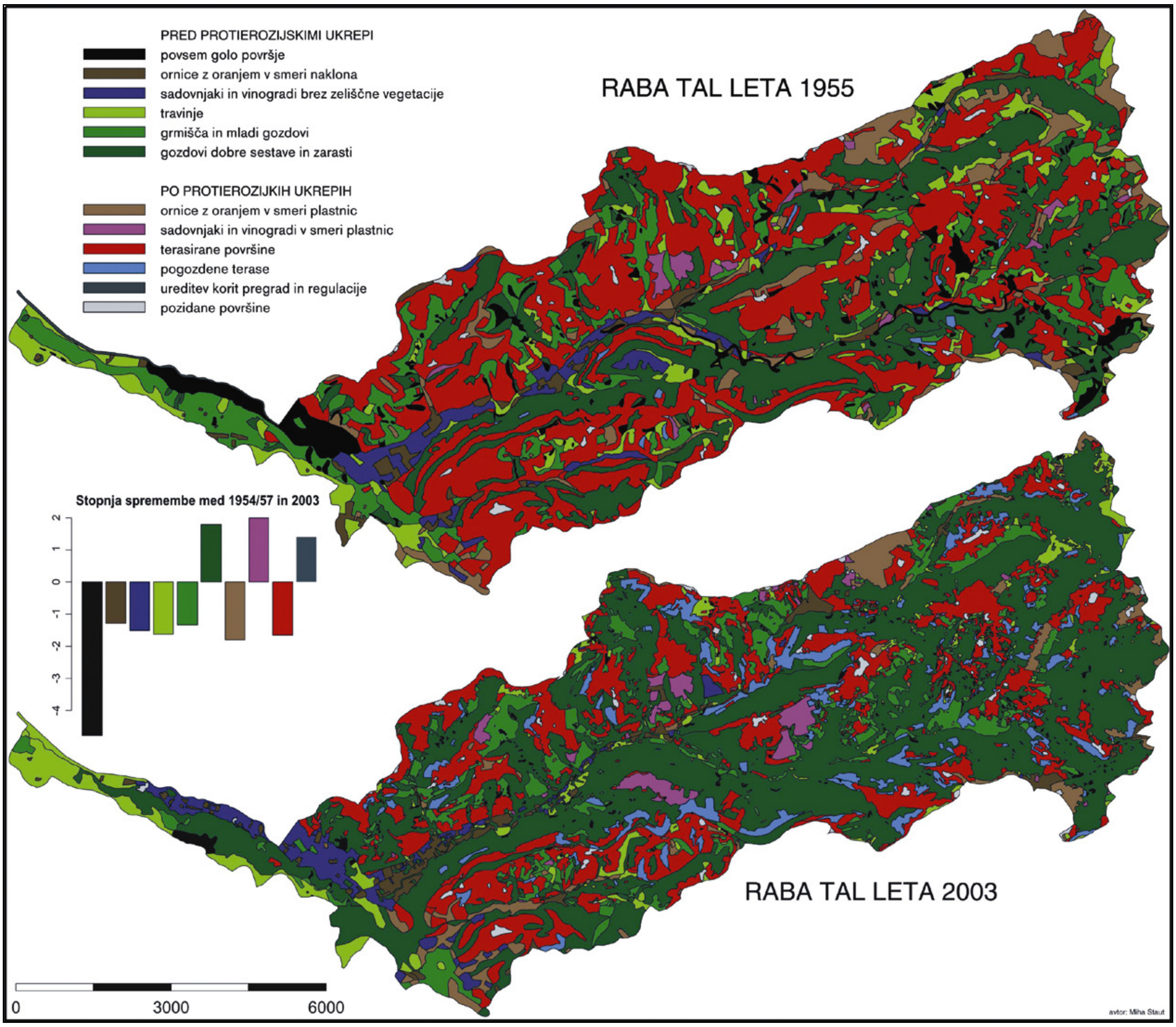
notranjosti ne zvišujejo linearno. Naprej je višanje zložno, vzhodno od črte Tinjan-Dekani-Labor pa se letne padavine začnejo zviševati hitreje (Ogrin, 1995). Mesečna razporeditev padavin kaže submediteranski značaj. Srednja letna temperatura zraka v porečju je 13,5 °C ob obali (Portorož) in 11,5 °C v notranjosti (Kubed) (Ogrin, 1995). Srednja dnevna temperatura je v Portorožu januarja 4,9 °C, julija pa 22,6 °C. V Kubedu je srednja dnevna januarska temperatura 2,9 °C, julijska pa 20,7 °C (Ogrin, 1995). Avtorja članka predpostavljata, da se povprečna letna temperatura v zadnjih petdesetih letih v porečju Dragonje ni bistveno spremenila. Zato sta vrednosti za posamezna podporečja povzela po delu PUH (Paulič, 1971).

Delujoče in nekdanje postaje, razmeščene po Slovenski Istri, je v kombinaciji z nekaterimi "poceni" podatki moč uporabiti pri izboljšanju kakovosti podatkov za posamezna podporečja s pomočjo interpolacije. Avtorja predpostavljata, da so za padlo količino padavin pomembni predvsem lokalni maksimumi v reliefu. S pomočjo stometrskega digitalnega modela reliefa so bile pridobljene vrednosti lokalnih maksimumov in s pomočjo tankoplastnih zlepkov (Mitasova & Mitas, 1993) skozi te točke povlečena površina. Glede na dostopne podatke, sta nadmorska višina postaje in povprečna letna količina padavin tesno povezani. S pomočjo linearne regresijske analize, kjer je količina padavin na padavinski postaji odvisna spremenljivka, vrednost karte na lokaciji postaje pa neodvisna, je bila izvedena kalibracija pridobljene karte s padavinskimi podatki. V pridobljeni enačbi kot neodvisna spremenljivka nastopa interpolirana površina lokalnih maksimumov, na osnovi katere je bilo moč oceniti padavine za območje celotne Slovenske Istre. Iz pridobljene zvezne karte je bila izdelana ocena povprečnih letnih višin padavin za posamezno podporečje analize (Sl. 3).

Spreminjanje rabe tal in širšega upravljanja prostora je kompleksen odsev številnih dogajanj v družbi. Bolje jih poznamo, manjša je možnost napake pri interpretaciji. Leta 1954, se pravi kmalu po vojni, je na območju porečja Dragonje še prevladovala kmetijska raba. Večina kmetijskih površin je bila obdelana, njive so bile zorane, sadovnjaki in vinogradi urejeni. Gozdni rob je bil na letalskih posnetkih jasno viden in izrazit. Kmetijstvo je v tistem času še močno oblikovalo pokrajino. Kljub nedavnim izselitvam kake polovice prebivalstva med letoma 1945 in 1954 (Titl, 1965) se njihov primanjkljaj na fotografijah še ne pozna toliko, saj potrebuje vegetacija več let, da zarase njive do take mere, da je njihova opuščenost opazna tudi na letalskih posnetkih. Zaradi tega so slike iz leta 1954 verjetno dober odsev stanja tudi za medvojno in bližnje predvojno obdobje. Še več časa pa je potrebnega, da parcela spremeni zemljiško kategorijo. To se začenja opažati na fotografijah iz leta 1975, še bolj pa na fotografijah iz leta 2003, kjer so obsežna nekdanja kmetijska območja povsem opuščena (Sl. 4). Prevladuje mnenje, da po 2. svetovni vojni razen redkih teras, ki imajo izrazito severno lego in so bile opuščene že v drugi polovici 19. st., pokrajina ni bila nikoli bolj obdelana (Titl, 1965). Odseljevanje prebivalstva iz zalednih predelov v obmorska mesta se je začelo takoj po 2. svetovni vojni, trajalo je v celotni drugi polovici 20. stoletja in je začelo upadati šele v devetdesetih letih 20. stoletja (Natek, 1990).

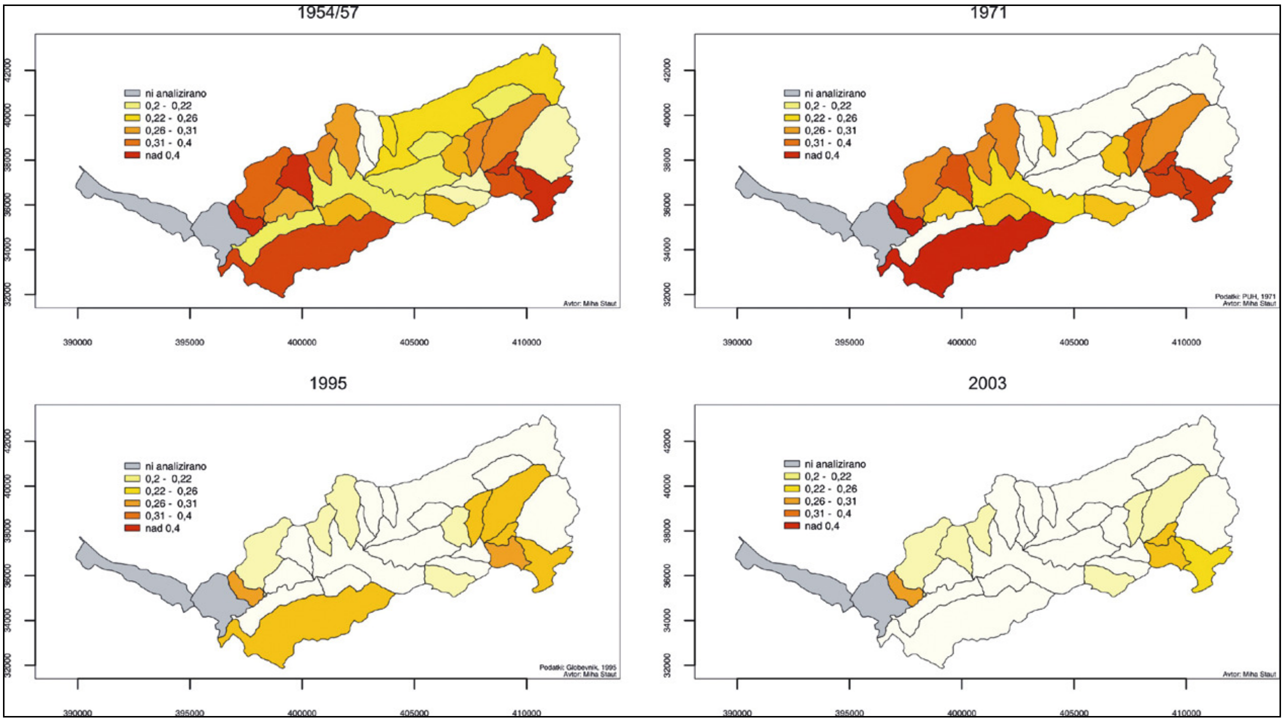


Sl. 3: Povprečne letne padavine po podporečjih 1961–1991 v mm.
Fig. 3: Average yearly precipitation by sub-catchments 1961–1991 in mm.



Sl. 4: Raba tal za leti 1955 in 2003 ter relativne spremembe zemljiških kategorij.
Fig. 4: Land use in the years 1955 and 2003 with relative change in land use types.

Uporabljena klasifikacija rabe tal se nanaša na izbrano metodo za oceno erozijskega koeficienta *Z*. Zato je tudi delitev nestandardna in le delno uporabna za tiste, ki se ukvarjajo z rabo tal. Najbolj obsežne spremembe rabe tal se kažejo v zmanjšanju terasiranih površin za 14 km^2 in povečanju gozda za 21 km^2. Največji relativni spremembi pa sta skoraj 5-kratno zmanjšanje povsem golih površin in kar 16-kratno povečanje površin ogozdenih teras. Pozorni moramo biti predvsem na kategorije intenzivnejših oblik obdelave, ki so se vse po vrsti zmanjšale, razen konturno oranih sadovnjakov in vinogradov, saj v 50-ih letih v porečju še ni bilo večjih plantaž javnega sektorja. Gozd je postopoma preraščal vse, ne glede na prejšnjo kategorijo. Zato lahko trdimo, da na tem območju ni prišlo do ekstensifikacije obdelave, ampak do opuščanja, ki se je začelo takoj po 2. svetovni vojni in začelo upadati šele v 90-ih letih prejšnjega stoletja. Vzrok takemu opuščanju gotovo tiči tudi v drastičnem upadu števila prebivalstva v obdobju od konca 2. svetovne vojne do začetka 90-ih let. Samo v letih 1945 do 1954 se je izselila skoraj polovica vsega prebivalstva iz Slovenske Istre (Titl, 1965). V kasnejših letih pa je hitri družbeno-gospodarski prehod in razvoj obmorskih mest (predvsem Kopra) pritegnil precejšnje število ljudi iz zaledja v bližino zaposlitve. Priseljevanje iz sprva drugih območij Slovenije, kasneje pa tudi iz drugih republik nekdanje Jugoslavije, pa je bilo usmerjeno predvsem v obmorski pas. Zato je število prebivalstva v porečju hitro nazadovalo in se ustalilo šele v 90-ih, a predvsem na račun velikih naselij v spodnji



Sl. 5: Spreminjanje koeficienta erozijske izraženosti φ po analiziranih obdobjih.
Fig. 5: Changing of the coefficient of erosional expression φ by sub-catchments.

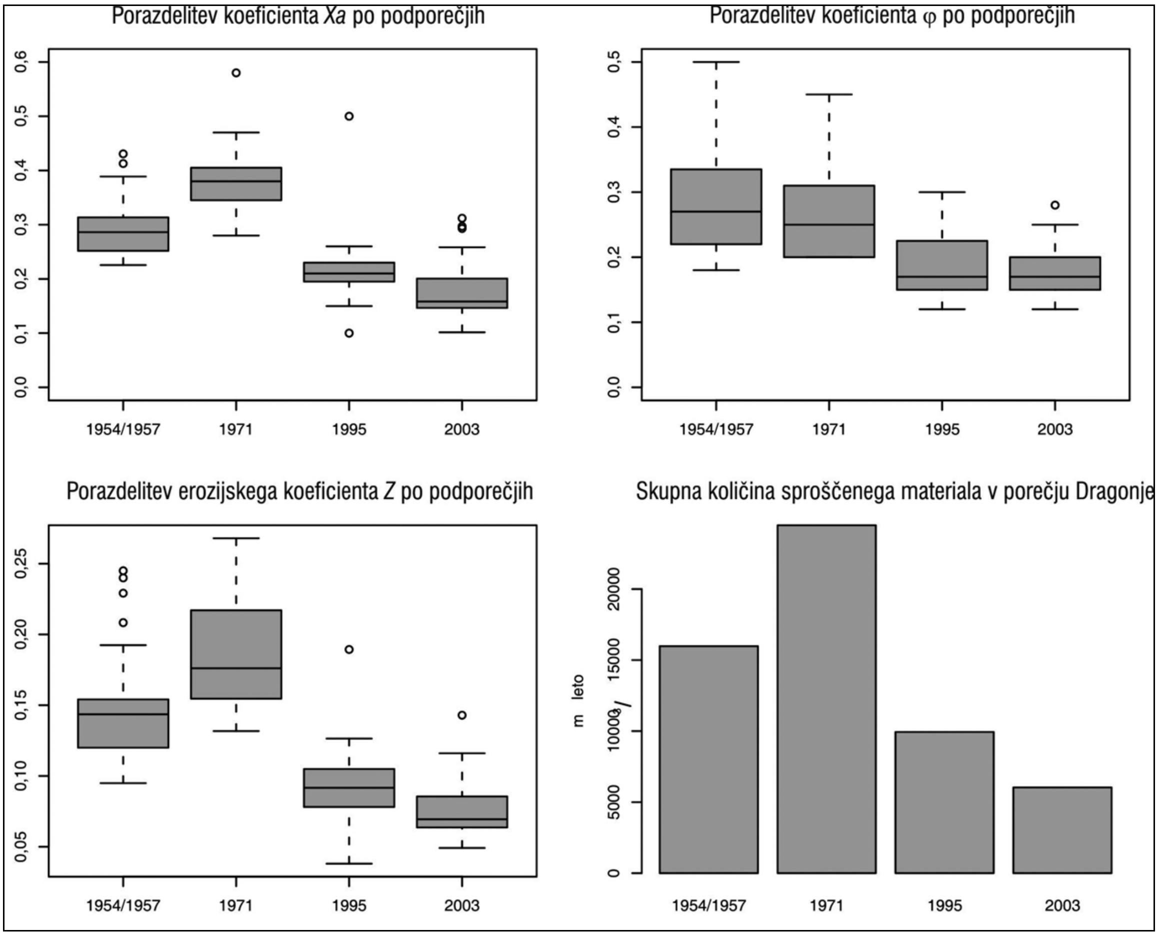
dolini Dragonje. V manjših in bolj oddaljenih naseljih pa je število prebivalcev nezadržno padalo še naprej. Ne le, da je nazadovalo število prebivalstva, marveč se je manjšal tudi delež kmetov.

Ocena koeficienta erozijske izraženosti se sledeč Gavrilovićevim napotkom opravlja kvalitativno. Kot omenjeno, sta avtorja pri tej nalogi uporabila interpretacijo letalskih posnetkov. Za vsako podporečje sta identificirala posamezne erozijske pojavne oblike in posebej ocenila celoten videz podporečja. Izvirni podatki so preobsežni za vključitev v omejeni prostor pričujočega članka, zato niso navedeni, lahko jih pa najdete v diplomskem delu M. Stauta (2004). Oceni za leto 1971 in za leto 1995 sta povzeti po PUH (Paulič, 1971) in Globevnik (2001). Na zemljevidih so prikazane ocene koeficienta erozijske izraženosti po posameznih hidrografskih podenotah za štiri analizirana obdobja (Sl. 5).

Na letalskih posnetkih je opazen trend precejšnjega zaraščanja vse od petdesetih let dalje. Večina koeficientov je v letih 1954/1957 večja kot dvajset let kasneje (Sl. 5). To pomeni, da je bila razgaljenost takoj po vojni velika in da se od tedaj pokrajina postopno zarašča. Pomembna razlika med letoma 1954 in 1975 je, da se je večina obsežnih erozijskih žarišč površinske erozije močno zarasla. Leta 2003 so na večini teh mest že borovi gozdiči, in šele terenski ogled razkrije veliko erodiranost prsti. Mednje sodijo na primer erozijsko žarišče v povirju Grdega potoka pod Gradinom, erozijsko žarišče na celotnem pobočju, ki se spušča iz Trebeš proti Stranici, ter erozijsko žarišče na celotnem vzhodnem pobočju pod Vršičem. Erozijski jarki so v letih 1954 in 1957 mnogo bolj izraziti kot leta 1975. Leta 1975 jih je že precej poraslih in tudi njihova okolica se zarašča. Leta 1954 pa se zarezujejo tudi v obdelovani del pokrajine, med terase, prečkajo ceste ali se usmerijo po kolovozu in ga nato zapustijo. Glede na letalske posnetke kaže, da je leta 1954 veliko prometnic dokaj novih, saj so useki na zgornjih straneh ceste razgaljeni, leta 1975 pa že kažejo znake zatravljanja. Večina se jih do leta 2003 popolnoma zarase. Natančnejši pregled razkrije, da se erozijska žarišča po večini zaraščajo od spodaj navzgor in z osojne na prisojno stran. Vzrok za zaraščanje od spodaj navzgor je, da se v podnožju erozijskega žarišča, kjer se naklon ponavadi zmanjša, nabira sproščeno gradivo. Če ga voda sproti ne odplavlja, se začne zaraščati. Zgornji del erozijskega žarišča je tako še vedno aktiven, a se postopoma "utopi" v lastnem sedimentu. Večina erozijskih žarišč ob vodotokih se zarašča na opisani način.

REZULTATI IN RAZPRAVA

Na sliki 6 so na grafih prikazane porazdelitve nekaterih izmed koeficientov, ki se vključujejo v Gavrilovićevo enačbo po štirih uporabljenih časovnih presekih. V časovnem poteku koeficienta erozijske izraženosti

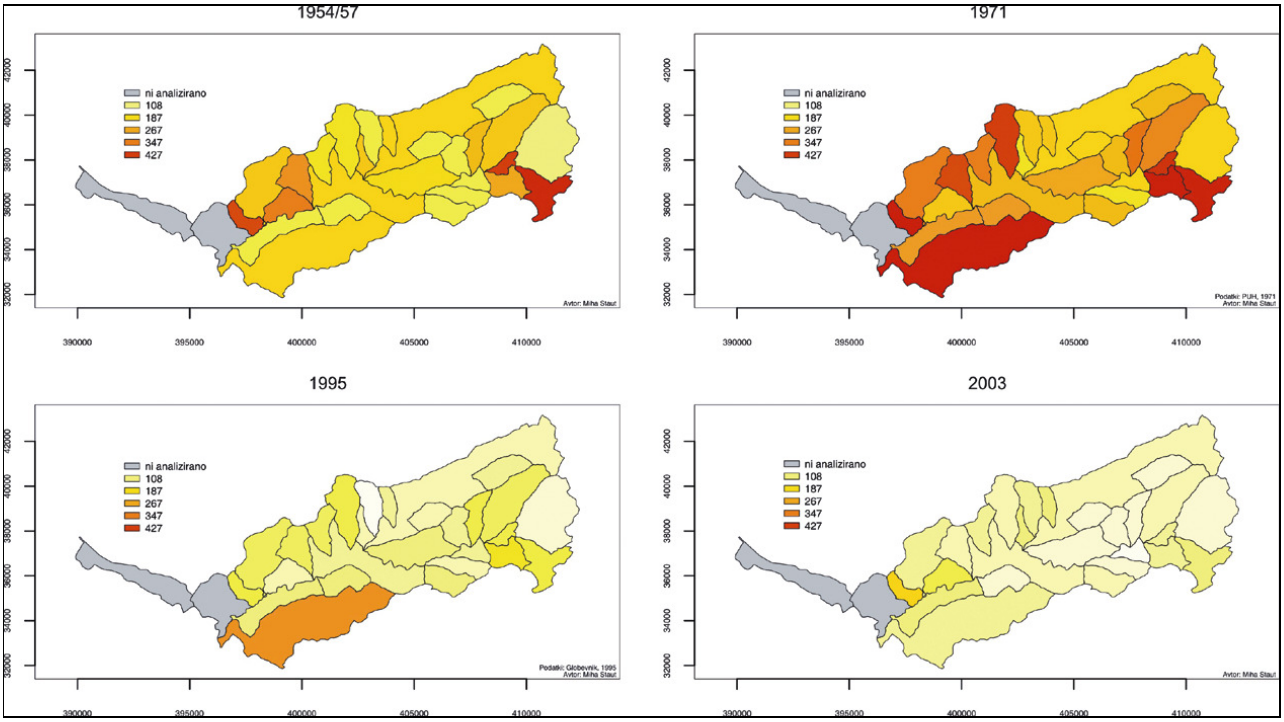


Sl. 6: Časovni razvoj koeficientov Gavrilovićeve metode.
Fig. 6: Temporal evolution of the coefficients of the Gavrilović method.

Z je opazno upadanje v celotni drugi polovici 20. stoletja. Drugače pa velja za kombinirani koeficient rabe tal in zaščite pred erozijo *Xa*. Vzrok dvigu v 70-ih letih morda tiči v različnih virih podatkov. Ocena za obdobji 1954/1957 in 2003 je bila opravljena v okviru diplomske naloge (Staut, 2004) s pomočjo interpretacije letalskih posnetkov, ocena za leto 1971 izvira iz analize Podjetja za urejanje hudournikov, leto 1995 pa je ocenila Globevnikova (2001) v svoji doktorski disertaciji. Glede na tedanje družbenogospodarske procese v porečju je težko verjeti, da se je intenzivnost obdelave med letoma 1955 in 1971 povečala. Tovrstne "napake" se vlečejo skozi enačbe do končne ocene sproščanja površinske erozije, saj ima v enačbah koeficient rabe tal in zaščitnih ukrepov ključno vlogo.

Če rezultat sproščanja delimo s površino porečja, dobimo specifično sproščanje oziroma intenzivnost sproščanja v $m^3\ km^{-2}\ leto^{-1}$. Karte na sliki 7 prikazujejo časovni potek po podporečjih. Tudi na njih je izrazito opaziti različne vire zajema podatkov. Rdeča barva ponazarja intenzivnejše sproščanje, svetlorumena pa šibkejše. V splošnem lahko ugotovimo dvoje: erozijski procesi so najbolj intenzivni v zgornjem delu porečja in na pritokih spodnjega dela porečja, in, kot je bilo razvidno že iz slike 6, upadanje z izjemo leta 1971. Specifično sproščanje, kot je vladalo v 70-ih letih, sodi v slovensko povprečje, kasneje pa je padlo pod to povprečje.

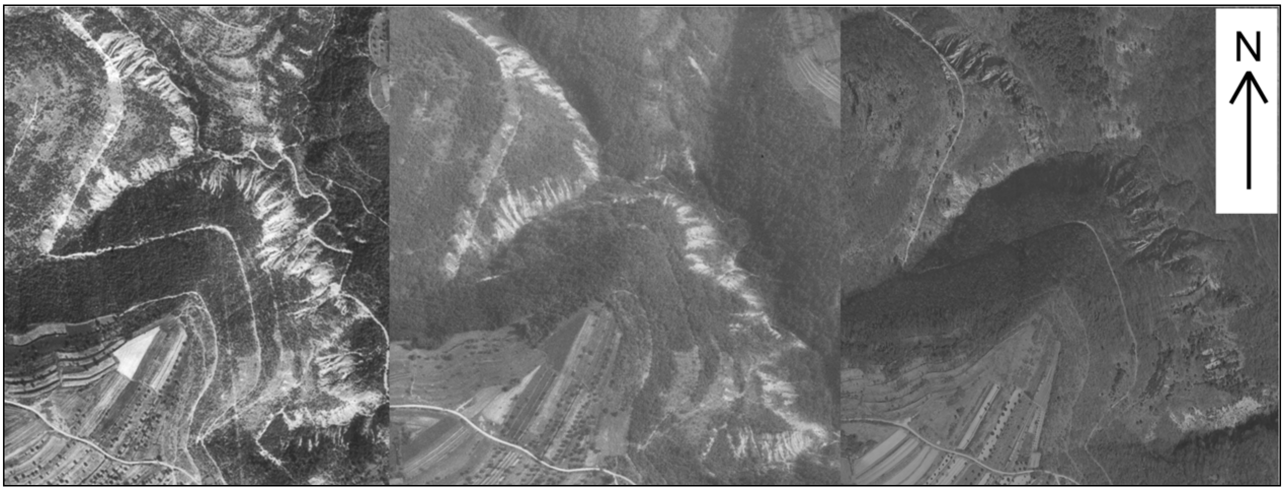
Avtorja sta primerjalno med leti 1954 z 1957 in 2003 ugotovila 7,6-kratno spremembo v površini erozijskih žarišč. To je iz 2,74 km^2 na 0,36 km^2. Študija PUH je za leto 1971 ugotovila 4,02 km^2 površin, na katerih so erozijski procesi v četrti ali peti stopnji razvitosti, ter 0,41 km^2 ožjih žarišč površinske erozije (Paulič, 1971). Glede na to, da raziskava v celotnem povojnem obdobju ugotavlja zmanjševanje koeficienta erozijske izraženosti, avtorja sklepata, da je razlika nastala predvsem zaradi različnih uporabljenih kriterijev, ki so kvalitativne narave. Na enako težavo nakazuje tudi raziskava Natka (1990), v kateri je ugotovil 4,06 km^2 površin z močno erozijo. Za leti 1975 in 1991, za kateri so bili letalski posnetki prav tako na voljo, avtorja povr-



Sl. 7: Spreminjanje specifičnega sproščanja W/F (m^3 km^{-2} $leto^{-1}$) po analiziranih obdobjih.
Fig. 7: Changing of specific sediment yield W/F (m^3 km^{-2} $year^{-1}$) by analysed temporal cross-sections.

šin erozijskih žarišč nista merila. Globevnik (2001) ugotavlja izrazito znižanje koeficienta erozijske izraženosti φ med letoma 1971 in 1995. V letih 1954 in 1957 je bilo okrog 58% erozijskih žarišč površinske erozije proti 42% erozijskih žarišč globinske in bočne erozije. Leta 2003 je bilo erozijskih žarišč površinske erozije le še 18%. To kaže na hitrejše in učinkovitejše zaraščanje le-teh. Četrti graf na sliki 6 razkriva nekakšen višek intenzivnosti erozijskih procesov v 70-ih letih. Ta višek gre predvsem na račun razlik v oceni koeficienta rabe tal in zaščitnih ukrepov *Xa*. To je dovolj jasno razvidno iz prvega grafa na sliki 6, ki prikazuje časovni potek tega koeficienta. V letu 1971 se koeficient *Xa* porazdeljuje mnogo višje kot v preostalih letih. Na drugi strani kaže koeficient erozijske izraženosti φ (drugi graf na sliki 6) konstantno upadanje z umiritvijo v zadnjih dveh analiziranih obdobjih. Na končni rezultat pa koeficient *Xa* vpliva precej bolj zaradi večje spremenljivosti. Od tod izrazite razlike v količini sproščene prepereline. V podporo hipotezi o dokaj konstantnem upadanju intenzivnosti erozijskih procesov govorijo letalski posnetki na slikah 8 in 9. Prva serija posnetkov prikazuje del porečja potoka izpod Puč. Kaže se jasen trend upadanja erozijske izraženosti od leta 1954 prek leta 1975 v leto 2003. Cesta, ki poteka po vzhodnem pobočju, ima leta 1955 povsem razgaljen usek, ki se do leta 1975 precej zaraste z zeliščno vegetacijo. Na posnetku iz leta 1954 je na južnem pobočju nad sotočjem obeh grap iz zahoda vidno že skoraj zaraslo erozijsko žarišče. V celotnem porečju primer ni osamljen in kaže na to, da so bili erozijski procesi v predvojnem obdobju morda še intenzivnejši.

Hipotezo potrjuje tudi ustno pričevanje dveh starejših domačink. V Trebešah je šestinosemdeset let stara ženica povedala, da je "brežina", kot je erozijsko žarišče na pobočju proti Stranici sama imenovala, gola od kar pomni. Le tu in tam je raslo kakšno drevesce. Med vojnama pa so pod Mussolinijevo vlado ta območja pogozdovali. V potrditev je navedla, da je še njena hči sadila bore pod vasjo in proti Gradinu. Na letalskem posnetku iz 1957 se v goličavah pod Gradinom vidi rastlinje (Sl. 9). Po njenem pričevanju na območju erozijskega žarišča niso pasli, ker je bilo površje golo in se ni izplačalo. Gospa iz Gradina (71 let, v Gradin poročena) pravi, da so na pobočju pod vasjo, kjer je nekoč bilo erozijsko žarišče, tudi pasli. Vendar so pasli tudi na nasprotnem pobočju, kjer je bil vedno gozd. Pasli so vse, kar so imeli, krave, koze in ovce, vendar ne vse na istem mestu. Ne ona ne mož ne znata pojasniti, kdaj in zaradi česa je območje ogolelo. Mož ve, da se je v času Mussolinijeve vlade pogozdovalo in da je gozd od takrat.



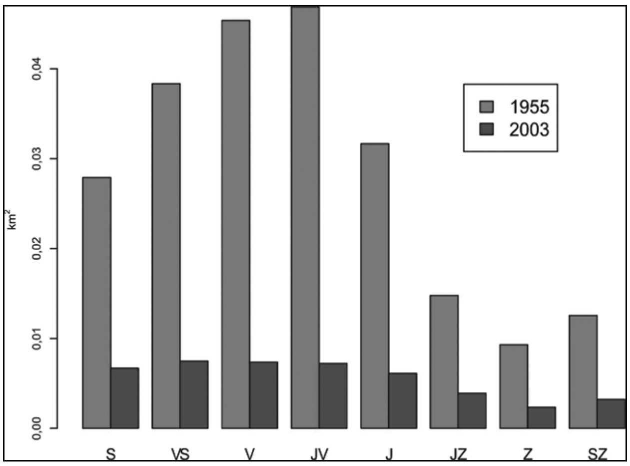
Sl. 8: Del porečja potoka izpod Puč v letih 1954, 1975 in 2003 (vir: Posebno aerosnemanje Slovenije, GURS, 1954, 1975 in 2003).
Fig. 8: A part of the catchment of the stream below Puče in the years 1954, 1975 and 2003 (source: Special aerofilming of Slovenia, GURS, 1954, 1975 and 2003).

Sl. 9: Zgornji tok Stranice pod Trebešami v letih 1957, 1975 in 2003 (vir: Posebno aerosnemanje Slovenije, GURS, 1957, 1975 in 2003).
Fig. 9: Upper part of the Stranica catchment under the village of Trebeše in the years 1957, 1975 and 2003 (source: Special aerofilming of Slovenia, GURS, 1957, 1975 and 2003).

Eden izmed stranskih proizvodov Gavrilovićeve metode je bila tudi karta erozijskih pojavnih oblik. S pomočjo te karte je v kombinaciji z digitalnim modelom reliefa mogoče ugotavljati značilnosti erozijskih žarišč glede na nekatere reliefne elemente površja, na katerem so se razvili, kot na primer naklon ali ekspozicija. Leta 1955 so imela glede na DMR-25 erozijska žarišča površinske erozije v povprečju 12,6° naklona, erozijska žarišča globinske in bočne erozije pa 25,4° naklona. Leta 2003 so imela izmerjena erozijska žarišča v povprečju 23,8° naklona. Vrednosti kažejo, da je DMR-25 pregrob za natančno ocenjevanje naklonov tako majhnih pojavov, saj zgladi izrazite naklone, ki so za erozijska žarišča značilni. Bolj zanimiva je porazdelitev

erozijskih žarišč glede na ekspozicije. Slika 10, ki to razmerje povzema, razkrije izrazito zgoščevanje razgaljenih površin predvsem na pobočjih, obrnjenih na vzhod in jugovzhod, medtem ko so zahodna pobočja skoraj povsem brez njih. Serija posnetkov na sliki 8 dokaj dobro prikazuje izrazito zgoščenost erozijskih žarišč na pobočjih z vzhodno ekspozicijo. Enaka podoba se kaže v obeh analiziranih letih (1954/57 in 2003), ki so bila zajeta neodvisno drug od drugega. O vzroku take razporeditve je težko govoriti z zanesljivostjo. Nakloni so glede na ekspozicije največji na severnih, ne pa na vzhodnih ali jugovzhodnih legah (Sl. 1). Ko gre za pojave, povezane z ekspozicijo, je mogoče pomisliti tudi na podnebne vplive, zlasti na različno osončenost posameznih površin. V takem primeru bi pričakovali intenzivnejše procese na južnih ali severnih ekspozicijah, ne pa na vzhodnih in jugovzhodnih. Za boljše razumevanje razmerja med ekspozicijo površja in razširjenostjo erozijskih pojavnih oblik bi bilo treba primerjalno ugotavljati njihove značilnosti na obsežnejšem območju, s podobnimi pokrajinskimi značilnostmi, in jih primerjati na več lokacijah.

Dokončno je težko ugotoviti, kateri dejavniki so vplivali na tako izrazito razgaljenost v preteklosti. Verjetno pa je nanjo vplivala kombinacija več dejavnikov, med katerimi so gotovo imele nezanemarljivo vlogo tudi človekove dejavnosti v pokrajini. Agrarna prenaseljenost je bila vse do obdobja po 2. svetovni vojni velik problem. Pokrajina je bila zatorej kmetijsko izredno izkoriščena. Ostanke te izkoriščenosti je opaziti še na posnetkih iz leta 1954, na primer na akumulacijski ravnici spodnje doline Dragonje, ki tedaj še ni bila regulirana in izpostavljena poplavam (Orožen Adamič & Lovrenčak, 1980). Agrarna prenaseljenost je dosegla višek v drugi polovici 19. stoletja, tik pred letom 1880 (Titl, 1965). Takrat je bila razprostranjenost teras največja in obdelovane so bile rekordno velike površine. To je edino obdobje, ko so delovale tudi terase z izrazito severno ekspozicijo. Vzroke gre iskati v tedanji gospodarski podobi Evrope, ki jo pestijo trtne bolezni. Kmetijska proizvodnja na območju današnje Slovenske Istre je bila tedaj usmerjena predvsem na tržaški trg. Zaradi trtnih bolezni v preostalem delu Evrope (v Franciji se je pridelek vina takrat znižal za 60%) pa so kmetje ves pridelek zlahka prodali na evropske trge. Zato so v tistem obdobju posekali številne oljčnike in jih zamenjali z vinogradi. Terase so tedaj urejali tudi na pobočjih z do 54% naklonom (Titl, 1965). Vzroke za izrazito erodiranost gre morebiti iskati tudi v tem obdobju. Leta 1880 so tudi slovensko ozemlje v večjem obsegu prizadele trtne bolezni. Veliko vinogradov je tedaj propadlo in zamenjale so jih vrtnine ter sadovnjaki, pridelki pa so bili ponovno usmerjeni na tržaški trg. Posledica tako obsežnih sprememb sta bila tudi preobrazba socialnih odnosov in način pridelovanja. Paolani (mestni kmetje) so zaradi potreb po večji intenzivnosti pridelave zemljo prodajali veleposestnikom. Ti pa so jo kolonom oddajali v najem (Titl, 1965). Kolonov ni zanimalo dolgoročno ohranjanje kakovosti zemljišča. Čeprav se je kolonat prednostno zgoščal v dolinah, je morebiti deloma tudi brezvestno ravnanje veleposestnikov in kolonskih najemnikov prispevalo k tedanjemu povečanju erodiranosti kmetijskih površin.



Sl. 10: Erozijska žarišča leta 1955 in leta 2003 glede na ekspozicijo.
Fig. 10: Badlands in 1955 and 2003 by exposition.

V času medvojne Italije je bila erodiranost zemljišč gotovo velik problem, saj so jo v tridesetih letih, v času velikih melioracijskih del, skušali sanirati s sajenjem črnega bora. Od takrat so tudi starejši nasadi bora na nekdanjih velikih erozijskih žariščih.

Erodiranost in intenzivnost erozijskih procesov so za obdobje po 2. svetovni vojni skušale oceniti že številne študije. Na porečju Dragonje so za to leto ugotovili skupno letno sproščanje v obsegu 44 000 m^3 $leto^{-1}$, od tega je na površinsko erozijo pripadalo 24 500 m^3 $leto^{-1}$ (Paulič, 1971). V ureditvenem obdobju, ki je potekalo v sedemdesetih in osemdesetih letih, so zgradili 192 manjših protierozijskih stabilizacijskih objektov in 5 večjih prodnih pregrad. Opravljali so tudi vegetacijska stabilizacijska dela. S črnim borom so pogozdili 42 ha površin (Globevnik, 2001). Globevnik (2001) je z enako metodo za leto 1995 ugotovila 60% zmanjšanje količine sproščenega preperelinskega gradiva iz erozijskih žarišč površinske erozije glede na 1971. Leta 1971 je bilo ugotovljenih 12,2 km aktivnih erozijskih jarkov. Od teh jih je bilo leta 1995 aktivnih le še 20%. Leta 2003 se je trend upadanja erozijske aktivnosti še nadaljeval. Vrednost sproščanja iz erozijskih žarišč površinske erozije je doseglo leta 2003 6665 m^3 $leto^{-1}$. Za obdobje 1954/57 pa je ta vrednost znašala W_{55} = 17.392 m^3 $leto^{-1}$, kar je manj kot za leto 1971. Razliko gre pripisati predvsem različnim kriterijem pri ocenjevanju koeficienta rabe tal in zaščitnih ukrepov *Xa*. S pomočjo metode RUSLE je bil v obdobju med letoma 1954 in 1994 ugotovljen upad v

količini sproščenega preperelinskega gradiva za 79%, do leta 2002 pa za 82% (Keesstra, 2007).

Vse omenjene raziskave ugotavljajo upad erozijske aktivnosti v povojnem obdobju. Razlogi za to tičijo predvsem v opuščanju in zaraščanju pokrajine. Glede na izsledke pričujoče raziskave se je v obdobju med 1955 in 2003 obseg gozda povečal za 46%. Tudi večina drugih kategorij prehaja v manj intenzivne oblike rabe. Razloge za to gre iskati predvsem v množičnem povojnem izseljevanju prebivalstva iz zalednih območij Slovenske Istre. Kmalu po vojni se je izselilo skoraj vse italijansko prebivalstvo. V tem obdobju je število prebivalcev padlo skoraj za polovico. Zaradi hitrega gospodarskega razvoja obalnih mest in zaposlovanja v nekmetijskih dejavnostih se je trend izseljevanja nadaljeval v celotni drugi polovici 20. stoletja. Največji upad števila prebivalstva in najslabšo starostno strukturo beležijo najbolj oddaljena naselja v zgornjem delu porečja. Tam so bili procesi opuščanja in zaraščanja tudi najbolj intenzivni. Severni del porečja je s svojo prisojno lego in večjo bližino zaposlitvenih središč nekoliko bolje ohranil prvotni značaj pokrajine.

CHANGES IN THE INTENSITY OF EROSION IN THE DRAGONJA RIVER CATCHMENT WITHIN THE 2ND HALF OF THE 20TH CENTURY

Miha STAUT
University of Primorska, Science and Research Centre Koper, SI-6000 Koper, Garibaldijeva 1, Slovenia
E-mail: miha.staut@zrs-kp.si

Matjaž MIKOŠ
University of Ljubljana, Faculty of Civil Engineering and Geodesy, SI-1000 Ljubljana, Hajdrihova ulica 28, Slovenia

SUMMARY

The paper deals with soil erosion in the Dragonja river catchment and its evolution from past to present. For the evaluation of the intensity of erosional processes, the Gavrilović method was used. It generality allows the estimation of the quantity of detached and washed material even from indirect sources, such as aerophotos. The time interval thus encompassed the span of the availability of data – i.e. *the second half of the 20th century. The analysis concentrates on land use changes and their influence on erosional processes. Estimates of the evolution of detachment intensity and a quantitative comparison of badlands and their position in the landscape were made. In the end, an attempt was made to parallel the established trend of the diminishing intensity of erosional processes with socioeconomic changes in the analysed period. During the analysed period a diminishing trend in the intensity of erosional processes was established. The non-linearity of this trend may probably be attributed to different sources of data for different temporal cross-sections with the very influential coefficient of land use and protection measures* Xa *being the main culprit. Erosional processes are generally most intensive in the upper reaches of the catchment and Dragonja's lower tributaries. Between the years 1955 and 2003, the surface of badlands shrunk from 2.74 km^2 to 0.36 km^2, meaning a 7.6-fold decrease. A peculiarity of sediment sources badlands is their continuous changing over different expositions with the maximum reached on southeastern and eastern expositions and the minimum reached on western expositions.*

Key words: Dragonja river, geomorphology, erosion, land use, aerial photography

LITERATURA

Darovec, D. (1992): Pregled zgodovine Istre. Knjižnica Annales 1, Koper, 88 str.

Gavrilović, S. (1970): Savremeni načini proračunavanja bujičnih nanosa i izrada karata erozije. V: Avtor knjige: Seminar Erozija, bujični tokovi i rečni nanos. Jugoslovenski komitet za međunarodnu hidrološku deceniju, Beograd, str. 85–100.

Globevnik, L. (2001): Celosten pristop k urejanju voda v povodjih. Doktorska disertacija. Univerza v Ljubljani, Fakulteta za gradbeništvo in geodezijo, Ljubljana, 176 str.

Keesstra, S. D. (2007): Impact of natural reforestation on floodplain sedimentation in the Dragonja basin, SW Slovenia. Earth Surf. Process. Landf., XXXII (1), 49–65.

Lal, R. (1994): Soil erosion by wind and water: problems and prospects. In: Lal, R. (ed.): Soil erosion research methods. St. Lucie press, Delray Beach, pp. 1–9.

Lovrenčak, F. (1994): Pedogeografija. Univerza v Ljubljani, Filozofska fakulteta, Ljubljana.

Mikoš, M. (1995): Soodvisnost erozijskih pojavov v prostoru. Gozdarski vestnik, 53, 342–351.

Mitasova, H. & L. Mitas (1993): Interpolation by Regularized Spline with Tension. I. Theory and Implementation. Math. Geol., 25(6), 641–655.

Morgan, R. P. C. (1979): Soil erosion. Longman, London, 113 p.

Natek, M. (1990): Sestavine prebivalstvene rasti po naseljih Koprskega primorja v obdobju 1869–1989. V: Orožen Adamič, M. (ur.): Primorje. 15. zborovanje slovenskih geografov. Zveza geografskih društev Slovenjije, Ljubljana, str. 79–86.

Ogrin, D. (1995): Podnebje Slovenske Istre. Knjižnica Annales 11, Koper, 320 str.

Orožen Adamič, M. & F. Lovrenčak (1980): Geografske značilnosti poplavnega sveta ob Dragonji in Drnici. Geografski zbornik, 19, 159–213.

Osnovna geološka karta SFRJ (1973): Tolmač lista Trst. Zvezni geološki zavod, Beograd, 1973.

Paulič, V. (1971): Erozija tal in hudourniki: Dragonja v Slovenski Istri. Diplomsko delo. Univerza v Ljubljani, Biotehniška fakulteta, Ljubljana.

Perko, D. (1994): Ekspozicije površja v Sloveniji. Geografski zbornik, 34, 120–147.

Petkovšek, G. (2002): Kvantifikacija in modeliranje erozije tal z aplikacijo na povodju Dragonje. Doktorska disertacija. Univerza v Ljubljani, Fakulteta za gradbeništvo in geodezijo, Ljubljana.

Pintar, J. & M. Mikoš (1983): Izdelava smernic in normativov z globalno usmeritvijo urejanja po ekosistemih, pojavnostih in ekološki primernosti ter načinov gospodarjenja s povirji voda. Poročilo VGI C-432, Ljubljana, 133 str.

Staut, M. (2004): Recentni erozijski procesi v porečju Dragonje. Diplomsko delo. Univerza v Ljubljani, Filozofska fakulteta, Ljubljana, 135 str.

Šraj, M. (2003): Modeliranje in merjenje prestrežnih padavin. Doktorska disertacija. Univerza v Ljubljani, Fakulteta za gradbeništvo in geodezijo, Ljubljana, 151 str.

Titl, J. (1965): Socialnogeografski problemi na koprskem podeželju. Založba Lipa, Koper.

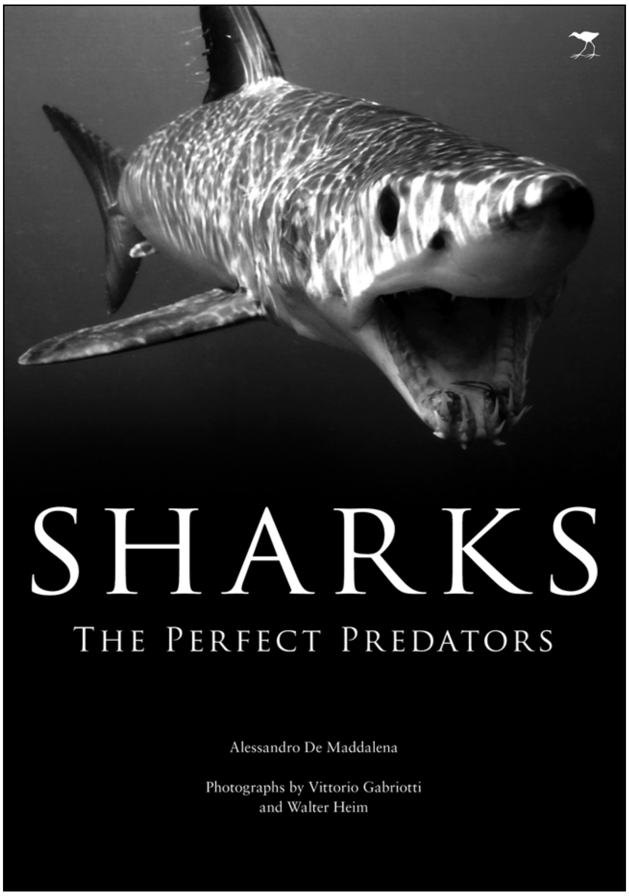
Vodoprivreda (1987): Karta erozije i katastar vodnih pojava reke Dragonje za dio sliva u SR Hrvatskoj. Rijeka, Vodoprivreda radna organizacija za vodno područje primorsko-istarskih slivova.

Zorn, M. (2007): Recentni geomorfni procesi na rečno-denudacijskem reliefu na primeru porečja Dragonje. Doktorska disertacija. Univerza v Ljubljani, Filozofska fakulteta, Ljubljana, 463 str.

Zupančič, B. (1998): Padavine. V: Fridl, J., D. Kladnik, M. Orožen Adamič & D. Perko (ur.): Geografski atlas Slovenije. Država v prostoru in času. DZS, Ljubljana, str. 98–99.

OCENE IN POROČILA
RECENSIONI E RELAZIONI
REVIEWS AND REPORTS

Alessandro De Maddalena: SHARKS – THE PERFECT PREDATORS
Jacana Media, Auckland Park, 2008, 198 p.



Alessandro De Maddalena is driven by his passion for sharks and a quest to learn more about them. He has written numerous scientific publications and several books on sharks. It is a great pleasure for me to write the review to his latest book, in which he so aptly describes the shark as being the perfect predator.

The wide variety of prey eaten by many shark species is well documented. It is common knowledge, particularly in the case of the tiger sharks, that the diet does occasionally include terrestrial animals and a stunning variety of inedible or indigestible items. Undeniably more intriguing, but not as well known, is the manner in which the shark tracks down its prey. The author provides a stimulating insight into the factors that may motivate a shark in its quest for food, and the tactics it utilizes to hunt down its prey.

The author concedes that there are still large gaps in our knowledge of shark predatory strategies. This is because most species are very difficult to observe, let alone study in the wild, and because many of their activities are performed at night. I am sure that this publication will stimulate further academic discussion and research in this field. More importantly, it will arm the enormous number of amateur shark watchers, who travel the globe to dive with sharks, with the necessary tools and insight to be able to make meaningful observations of sharks in their pursuit of prey. I would urge readers to submit their observations, using the reporting form provided in Appendix I.

The book is greatly enhanced by numerous photographs, captured by Vittorio Gabriotti and Walter Heim. I am confident that it will inspire its readers to a greater level of respect and admiration for a group of animals that were once largely feared and despised.

Geremy Cliff

OBLETNICE
ANNIVERSARI
ANNIVERSARIES

MORSKA EKOLOGINJA PROF. DR. ALENKA MALEJ – JUBILANTKA

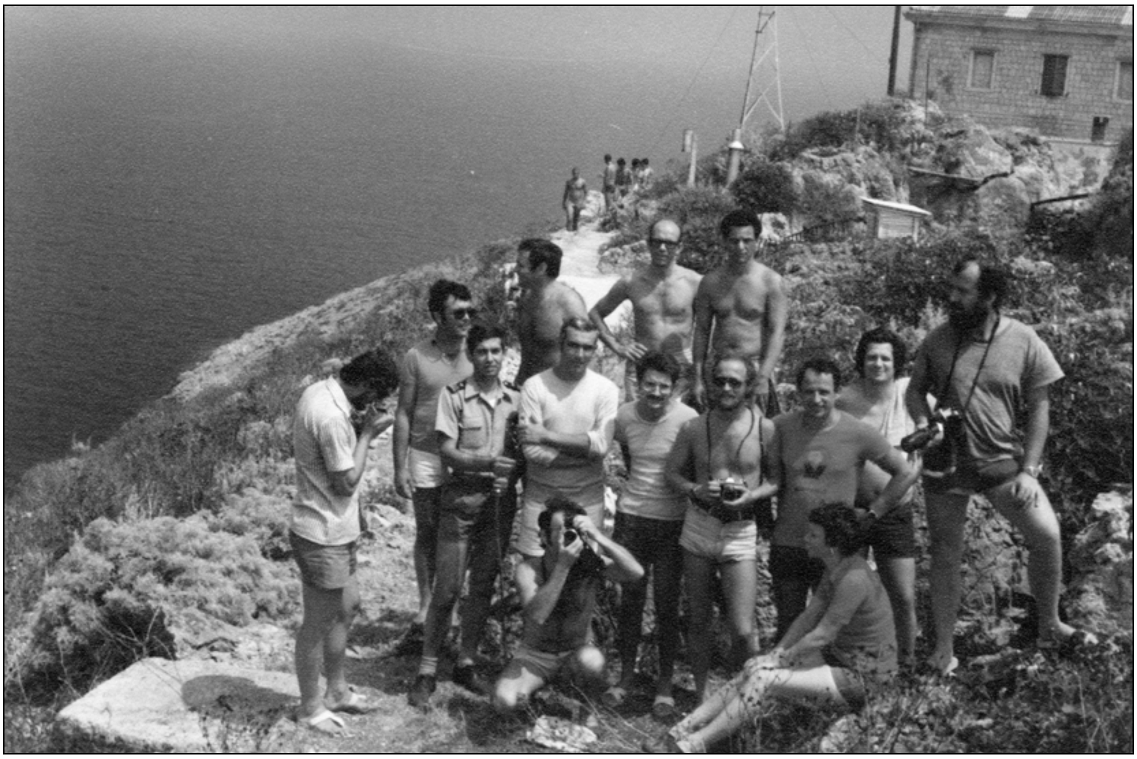
Prof. dr. Alenka Malej, vodilna slovenska raziskovalka na področju morske biologije in ekologije obalnih voda, je letos dopolnila 60 let. To je primerna priložnost, ob kateri lahko povzamemo slavljenkine dosedanje dosežke, ki jih ni tako malo. V posebno čast mi je, da lahko o tem pišem jaz, saj je bila moja mentorica tako pri diplomski nalogi kot tudi pri magisteriju in doktoratu.

Rodila se je 5. aprila 1948 v Ljubljani, vendar se je že kot 4-letna deklica leta 1952 s starši preselila v Marezige, kjer je preživljala otroštvo. Zaradi takrat neurejenega vodovodnega sistema v Marezigah je med drugim zbolela za paratifusom in hepatitisom. Spominja se, kako so otroci že zelo zgodaj bili primorani hoditi v hudo strmino po svojo kanglico vode. Hudomušno pa se nasmeje ob pripovedovanju svojega uspešnega padca v jamo z gašenim apnom. Že takrat jo je privlačilo morje, ki ga je lahko opazovala v daljavi. Iz šole, kjer so tudi živeli, ga je namreč videla. Žal pa do njega ni prišla ravno pogosto zaradi razdalje, ki bi jo bilo treba prehoditi, ter zelo redkih avtobusnih povezav. Je pa zato bila v stalnem stiku z naravo, ki ji je bila nadvse ljuba, tako v Marezigah kot tudi pri starih starših, ki so živeli na kmetiji. Na otroštvo jo vežejo prijetni spomini, če le odmisli pomanjkanje vode. Iz Marezig, kamor se še danes rada vrača, se je po četrtem razredu osnovne šole s starši in sestro preselila v Koper.

Po končani gimnaziji leta 1966 se je iz Kopra odpravila študirat v Ljubljano. Leta 1972 je diplomirala na Oddelku za biologijo Biotehniške fakultete na ljubljanski univerzi. Tema diplomske naloge iz antropologije je bila daleč od kasnejše strokovne in znanstvene usmeritve. Na isti fakulteti je pod mentorstvom prof. dr. Jožeta Štirna z magistrsko nalogo Biomasa in struktura zooplanktona vzhodnega dela Tržaškega zaliva s posebnim ozirom na onesnaževanje zaključila podiplomski študij Oceanografija in morska biologija. Doktorirala je leta 1984 pod mentorstvom prof. dr. Adama Benovića na Prirodoslovno-matematični fakulteti Univerze v Zagrebu z disertacijo Produkcijske in biokemijske značilnosti zooplanktona v Severnem Jadranu.

Februarja 1972 se je, še pred končano diplomo, kot učiteljica telesne vzgoje zaposlila na osnovni šoli v Kopru. Po končani diplomi pa se je septembra 1972 zaposlila kot stažistka na Morski biološki postaji Nacionalnega inštituta za biologijo, kjer je še danes. Pričela je s preučevanjem zooplanktona. Leta 1977, ko so se v Jadranskem morju množično pojavile mesečinke *(Pelagia noctiluca),* se je osredotočila na meduze, ki so še danes njen priljubljen raziskovalni objekt. Nadaljnje študije te meduze ji je omogočil leta 1978 odobren UNEP/MAP program za Sredozemsko morje za mesečinko. Pri delu, ki ga opravlja, ji je najbolj všeč, da gre lahko na morje in se tudi potaplja, čeprav žal premalo, kot rada poudarja. Všeč ji je tudi, da se lahko srečuje z veliko najrazličnejšimi ljudmi z vsega sveta, spoznava nove stvari, ni togih urnikov in predvsem se lahko ukvarja z znanostjo, kar se ji zdi prav poseben privilegij.

Rada se spominja svojega prvega daljšega službenega potovanja, ko je gostovala v več kot sto let starem laboratoriju za preučevanje morja v Plymouthu (Velika Britanija). Rezultat tega daljšega bivanja v tujini je velikokrat citiran članek Diel patterns of ammonium excretion and grazing rhytms in *Calanus helgolandicus* in surface stratified waters, ki ga je v soavtorstvu z Rogerjem P. Harrisom objavila leta 1986 v Marine Ecology Progress Series. Za udeležbo na svojem prvem kongresu CIESM, ki je bil leta 1978 v Antalyji (Turčija), se je morala skregati z nadrejenimi, nakar si je sama priskrbela finančna sredstva in se ga udeležila. Poleg udeležbe na mednarodnih kongresih rada sodeluje tudi na raziskovalnih ekspedicijah in lahko se pohvali s skupno prek 250 dnevi terenskega dela na morju. Najbolj so ji ostale v spominu ekspedicije z raziskovalno ladjo Mohorovičić Hidrografskega inštituta vojne mornarice Jugoslavije. Teh se je udeležila kar petkrat, od tega so bile tri daljše in so se pričele v Tržaškem zalivu ter potekale vse do Jonskega morja. Najdaljša je trajala kar 26 dni. Teh ekspedicij so se udeleževali raziskovalci najrazličnejših profilov vseh morskih inštitucij takratne Jugoslavije. Poleg ekspedicij v Jadranskem morju, katerih se udeležuje še danes (Mljetska jezera, južni Jadran), je sodelovala na ekspedicijah v vzhodnem Atlantiku (britanska ladja), v Guelfo Nuevo (Argentina), v zalivu Aqaba na Rdečem morju (Izrael), na ustju reke Rhone (Francija) ter ob sredozemski obali v Turčiji.



Utrinek s Palagruže (ekspedicija "Mohorovičič", 1976).

Je nosilka številnih nacionalnih raziskovalnih in raziskovalno-razvojnih projektov ter vodja številnih mednarodnih projektov. Kot strokovnjakinja sodeluje predvsem pri dejavnostih na področju raziskav morja ter prenosu tega znanja v prakso. Delovala je kot ekspert za agencijo ZN za okolje (UNEP), Regional Seas Programme, MAP (od leta 1981 dalje), bila članica delovne skupine za ministrsko konferenco MED 21 on Sustainable Development in the Mediterranean Region (Tunis 1994). Bila je članica italijansko-jugoslovanske komisije za zaščito Jadranskega morja (1985–1991) in članica mednarodne koordinacijske skupine Observatorija severnega Jadrana (1986–1995). V obdobju 1991–1994 je bila dejavna pri včlanitvi R Slovenije v pomembne mednarodne organizacije (Medvladna oceanografska komisija – IOC; Sredozemski akcijski načrt Agencije Združenih narodov za okolje UNEP/MAP; Mednarodna komisija za raziskave Sredozemskega morja – CIESM), v katerih deluje še sedaj. Je kontaktna oseba (akcijski naslov) za IOC v Parizu in predsednica nacionalnega odbora za IOC, nacionalna koordinatorka MED POL programa pri UNEP/MAP ter zastopa Slovenijo v MARS (Evropski mreži morskih raziskovalnih postaj); v slednji od leta 2008 deluje kot članica izvršnega odbora. Je tudi članica Nacionalne komisije UNESCO ter predsednica Naravoslovnega odbora te komisije. Od leta 2004 je direktorica Operativnega centra Slovenija, International Ocean Institute, ki deluje v okviru Morske biološke postaje Nacionalnega inštituta za biologijo. Leta 2008 pa je postala tudi članica mednarodnega strokovnega odbora EMUNI (Evro-sredozemske Univerze). Poleg tega je članica uredniških odborov znanstvenih revij Annales, Acta Biologica Slovenica in Acta Adriatica.

Vodja Morske biološke postaje je neformalno od sredine osemdesetih, formalno pa je bila za vodjo imenovana sredi devetdesetih let. Sredi osemdesetih je tudi resno razmišljala o menjavi službe. Povod za to je bila skorajšnja selitev v Novo mesto. Možu Andreju so namreč v tamkajšnji bolnišnici ponudili mikavno delovno mesto in rešitev stanovanjskega problema, sama pa se je že dogovarjala za delo v razvojnem oddelku farmacevtskega podjetja Krka Novo mesto. Seveda sta vse postavila na glavo sinova, ki sta se selitvi na Dolenjsko odločno uprla.

Njeni najbolj negativni službeni spomini so vezani na obdobje gradnje novih prostorov Morske biološke postaje, ko so bile razmere za delo nevzdržne. Vse skupaj so spremljali še občasni zastoji gradnje, ko je prihodnost Morske biološke postaje tako rekoč visela v zraku. Seveda pa premagajo tisti pozitivni spomini in občutki, ki jih zagotavljajo uspešne ekspedicije, prepoznavnost Morske biološke postaje v svetu, uspeli zagovori doktorskih, magistrskih in diplomskih nalog in nasploh vsi uspehi v "hiši".

Prvi pomemben oseben dosežek v znanosti se ji zdi objava članka Net-zooplankton biomass of the Adriatic

Sea v soavtorstvu z A. Benovićem, M. Specchijem in S. Fonda-Umani leta 1984 v Marine Biology (Berl.). Sicer pa ima preko 350 objavljenih del, mnoga v uglednih mednarodnih revijah. Leta 1989 je, skupaj s sodelavcema Jadranom Faganelijem in Nedo Fanuko, prejela Kidričevo nagrado za znanstvenoraziskovalne dosežke, leta 2000 pa priznanje ambasador RS v znanosti. Leta 2007 je bila imenovana tudi za ambasadorko Zelene knjige EU za pomorsko politiko.

V naziv redne profesorice za področje ekologije na Univerzi v Ljubljani je bila izvoljena 18. februarja 2003. Predavala je v okviru rednih tečajev o varstvu okolja za srednješolsko mladino v Ljubljani in Kopru (1986–1991), sodelovala pri izvedbi naravoslovnih taborov za srednješolce, ki jih je organiziral Slovenski inštitut iz Trsta (1990–1992), pri izvajanju stalnega strokovnega izpopolnjevanja delavcev v vzgoji in izobraževanju v Sloveniji (1998) in zamejstvu (1996) ter pri tečajih za mentorje mladih raziskovalcev, ki jih je financiralo Ministrstvo za šolstvo in šport. Več let je sodelovala pri izvajanju učnih programov na dodiplomskem in podiplomskem študiju ljubljanske univerze za študente Biotehniške fakultete in medfakultetnega študija varstva okolja, predavala je študentom Fakultete za pomorstvo in promet ter predmet morska biologija tudi na podiplomskem študiju ljubljanske Akademije za likovno umetnost. Od leta 2003 sodeluje pri izvajanju dodiplomskega študija okolje na Univerzi v Novi Gorici, od leta 2007 pa tudi pri novem bolonjskem magistrskem študijskem programu Morska biologija, ki se izvaja v sodelovanju s primorsko univerzo in Univerzo v Trstu. Veliko vabljenih predavanj je imela v tujini, in sicer na Univerzi v Stockholmu in Univerzi Umeĺ (Švedska), Univerzi Pierre et Marie Curie v Parizu (Francija), Interuniverzitetnem centru v Eilatu (Izrael), Univerzi v Trstu in Univerzi v Sieni (Italija), Univerzi Griffith v Brisbane (Avstralija), na Marine Biological Association of UK in Plymouth Marine Laboratory (Velika Britanija), Horn Point Environmental Laboratory Univerze v Marylandu (ZDA), Inštitutu za znanosti o morju Middle East Technical University (Turčija), Inštitutu R. Bošković (Hrvaška). Bila je tudi mentorica štirim doktorandom, petim magistrantom in devetim diplomantom ter somentorica dvema diplomantoma, vendar z mentorstvom nadaljuje še danes.

Meduze so še danes njeno priljubljeno raziskovalno področje.

Vseskozi si je prizadevala za predstavitev raziskovalnih dosežkov javnosti tako s prispevki v različnih sredstvih javnega obveščanja, s poljudnoznanstvenimi članki, s sodelovanjem pri poljudnoznanstvenih in drugih radijskih in televizijskih oddajah. V letu 2006 je skupaj s sodelavci Morske biološke postaje (NIB) v oviru projekta SZF/Wonders sodelovala na Sejmu znanosti v Madridu in je tudi dobitnica priznanja Slovenske znanstvene fundacije Prometeus znanosti za odlično komuniciranje znanosti.

Po tako pestri karieri sedaj želi predati vodstvo Morske biološke postaje in se posvetiti zgolj raziskovalnemu delu, s katerim je tudi začela svojo uspešno znanstveno pot. Ni pa skrivnost, da bi rada imela tudi več časa za zdrav, športen način življenja kot tudi za svojo družino, predvsem svoje vedoželjne vnuke. Seveda ji ob njeni šestdesetletnici to iskreno privoščim in zaželim še mnogo veselih dogodkov ter vsaj tako uspešno pot še naprej.

Vesna Flander Putrle